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THE EFFECT OF ENVIRONMENT UPON THE PRO-
DUCTION OF SPORANGIA AND SPORANGIOLA
IN *BLAKESLEA TRISPORA* THAXTER¹

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The purpose of the following experiments was to study the effects of various environmental conditions upon the production of the two types of sporangia in *Blakeslea trispora*; the large solitary sporangia which possess a columella; and the smaller ones, termed sporangiola, which lack a columella and occur in considerable numbers over the surface of large spherical sporangioliferous heads.

The effect of environment upon the production of sporangia in the Mucorales has already been studied by several botanists. Klebs ('96), working with *Mucor racemosus* which has no sporangiola, studied the effect of quantity and quality of the substrate upon sporangial production, also the effects of humidity, atmospheric pressure, temperature, and light. He discovered that the quantity and quality of the substrate play the dominant rôle in the production of sporangia. Tavel ('86) and Bachmann ('95) reported the effect of nourishment upon the formation of the two types of sporangia in *Thamnidium elegans*. Under favorable conditions of nourishment continued through several generations, the sporangiola became as large and contained as many spores as the sporangia. Conversely,

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with poor nourishment, the terminal sporangia changed into sporangiola, often with but one spore. Brefeld ('91) found that under unfavorable conditions of nourishment the terminal sporangia of *Chaetostylum Fresenii* abort, but that they are again produced under favorable conditions. In *Choanephora*, a genus closely related to *Blakeslea*, little experimental work has been reported, although Cunningham ('79), Couch ('29), Möller ('01), and Thaxter ('14) mention that sporangia are generally produced upon exhausted media.

In *Blakeslea trispora*, first described by Thaxter ('14) and studied in the following experiments, conidia are absent and the sporangia and sporangiola show numerous variations and intergradations. The sporangia vary in diameter from 10 to 80 μ (pl. 25, figs. 7 and 10). The sporangiola are sometimes borne upon solitary heads at the ends of erect, unbranched sporangiophores, but usually the heads are in groups of 10 or more (pl. 25, figs. 1-5). The sporangiola are typically 3-spored, rarely 4- or 6-spored, and are attached to the heads by a small spherical vesicle. When mature the sporangium falls away, carrying the vesicle with it. The spores are variable in size but in general are alike in all types of sporangia. They are longitudinally striate, and are provided at each end with a cluster of delicate, radiating appendages like those of the sporangiospores of *Choanephora*.

Thaxter ('14) first isolated *Blakeslea trispora* from a culture of *Botrytis* which in turn had been obtained from flowers of the cow-pea. It seems to occur as a weak parasite on various plants (Jochems, '27). It has been shown by Weber and Wolf ('27) to be heterothallic. It is closely related to *Choanephora*. Thaxter homologized the conidia of *Choanephora* with the sporangiola of *Blakeslea*, and suggested that the conidia are to be regarded as monosporous sporangiola. Although he was unable to separate mechanically an outer thin sporangial wall from the conidia of *Choanephora*, his figures of the somewhat abnormal conidia of *C. Cucurbitarum* indicate its existence. In any case, the homology of conidia and sporangia is evident in these genera.

All of the following experiments were performed with two strains of *Blakeslea trispora*. One strain, hereafter called "Strain A," was received through the kindness of Dr. A. F. Blakeslee of the Carnegie Institution of Washington. The other strain, "Strain X," was received from the Centraalbureau voor Schimmelcultures, Baarn, Netherlands. Neither strain deviated greatly from Thaxter's description except that sporangia of the type shown by Thaxter (see pl. 25, fig. 11) were never observed. Both strains produced zygosporoes when crossed with a minus-strain. The strains differed from each other in several respects. Strain X always produced much more mycelium than did Strain A. In Strain X there were always more sporangia than sporangiola, while in Strain A there were always more sporangiola. Strain A produced more yellow-orange pigment upon potato-dextrose agar. There was no discernible difference, however, in the type and size of the spores, sporangia, or sporangiola of the two strains. While the differences do not seem sufficient to warrant a new species, the two strains could always be easily distinguished when grown upon the same petri dish, and their growth reactions often suggested different species.

EFFECT OF VARIOUS MEDIA

Both strains were used in all experiments. The various media were made up with distilled water. The petri dish cultures were kept in an incubator which varied daily about one degree from a mean of 23° C. unless otherwise stated. All media and utensils were sterilized at 15 pounds pressure for 30 minutes in the autoclave (to be rid of a species of *Bacillus* which invaded the laboratory during the course of these experiments). Single-spore cultures were started from both strains, using the dilution method outlined by Barnes ('35). Spore suspensions were prepared by transferring 10 loopfuls of sporangiola to 15 cc. of sterile water, and 5 drops of this suspension were used in making inoculations. The estimates of the per cent sporangia or sporangiola are not as exact or as quantitative as our tables indicate. They were made from

counts in three or four sectors of petri-dish cultures, using a binocular dissecting microscope. Two petri dishes were used for each strain. The whole experiment was performed twice, and the results were taken from the two experiments (table I).

The relative numbers of sporangia and sporangiola were the same whether spores from sporangia or sporangiola, or even mycelium, were used as inoculum. In the case of potato-dextrose agar, mycelium five months old, dried, and shriveled, was used, but the culture showed the usual distribution of 65 per cent sporangiola with Strain A. The type of sporangia produced was also unaffected by the number of spores used in inoculation, a colony started with one spore having the same distribution as one with from 50 to 100 spores. Repeated transfers had no effect. A colony started from a dish which was the last of a series of 50 transfers had the same relative number of sporangia and sporangiola as that produced by a direct inoculation of spores from the original culture which had not been transferred. No difference was noted in transfers made by platinum needle or spore suspensions in water, nor did the keeping of spore suspensions in distilled water for three weeks affect the results obtained.

Both strains grew most readily upon potato-dextrose agar and the potato agar. In 48 hours the substrate was covered with mycelia and there was abundant fructification. As is seen from the table, in no case was one type of sporangia produced to the exclusion of the other. Upon all media Strain X produced much more mycelial growth than Strain A. Upon Endo's agar and peptone agar Strain A repeatedly produced a preponderance of sporangiola. Mycelial growth was never dense upon Endo's agar and growth was generally restricted. Although sporangiola as well as sporangia were produced upon this media, the distribution in Strain X was quite different from that in the Strain A.

A potato medium was prepared as follows: 5 cc. potato decoction,¹ 95 cc. distilled water, 2 g. agar, and 2.5 g. sugar. The following sugars were used: dextrose, mannose, galactose,

¹ Prepared by steaming 200 gms. of sliced potato in 1000 cc. of water for one hour. The extract was then decanted, filtered, and made up to one litre.

TABLE I
EFFECT OF VARIOUS MEDIA UPON TYPE OF SPORANGIA

Medium	Time of appearance of mycelial growth		Time of appearance of fructification		Distribution of sporangia and sporangiola	
	Strain A	Strain X	Strain A	Strain X	Strain A	Strain X
Rat-dung agar	24 hrs.	24 hrs.	No fruiting	No fruiting		
Yeast-dextrose agar	24 hrs.	24 hrs.	No fruiting	No fruiting		
Nutrient agar	24 hrs.	24 hrs.	No fruiting	No fruiting		
Nutritive caseinate agar	24 hrs.	24 hrs.	No fruiting	No fruiting		
Brain-veal agar	24 hrs.	24 hrs.	No fruiting	No fruiting		
Corn-meal agar	24 hrs.	24 hrs.	72 hrs.	72 hrs.	Sporangia 30% Sporangiola 70%	Sporangia 70% Sporangiola 30%
Eosine methylene-blue agar	24 hrs.	24 hrs.	72 hrs.	72 hrs.	Sporangia 30% Sporangiola 70%	Sporangia 70% Sporangiola 30%
Bacto malt-extract agar	24 hrs.	24 hrs.	48 hrs.	72 hrs.	Sporangia 30% Sporangiola 70%	Sporangia 70% Sporangiola 30%
Banana agar	24 hrs.	24 hrs.	72 hrs.	72 hrs.	Sporangia 40% Sporangiola 60%	Sporangia 70% Sporangiola 30%
Endo's agar	24 hrs.	24 hrs.	72 hrs.	48 hrs.	Sporangia 10% Sporangiola 90%	Sporangia 40% Sporangiola 60%
Potato slices	24 hrs.	24 hrs.	No fruiting	No fruiting		
Peptone agar	24 hrs.	24 hrs.	72 hrs.	72 hrs.	Sporangia 10% Sporangiola 90%	Sporangia 60% Sporangiola 40%
Potato agar	24 hrs.	24 hrs.	48 hrs.	48 hrs.	Sporangia 30% Sporangiola 70%	Sporangia 90% Sporangiola 10%
Urea agar	No growth	No growth				
Ammonium-carbonate agar	No growth	No growth				
Starch-dextrose agar	24 hrs.	24 hrs.	72 hrs.	72 hrs.	Sporangia 15% Sporangiola 85%	No growth
Potato-dextrose agar	24 hrs.	24 hrs.	48 hrs.	48 hrs.	Sporangia 35% Sporangiola 65%	Sporangia 85% Sporangiola 15%

maltose, sucrose, lactose, raffinose, rhamnose, arabinose, xylose, and invert sugar. The distribution of sporangial types was not at all affected in Strain A. Upon all the sugars except lactose, raffinose, and mannose, the mycelium was pigmented, while no pigment was produced upon the control (potato agar without sugar). In Strain X there was much more mycelium but no pigmentation. The control with this strain showed all sporangia and no sporangiola. Mannose gave the same results as the control. All the other sugars showed 85 per cent sporangia to 15 per cent sporangiola.

EFFECT OF QUANTITY OF FOOD

The two strains reacted differently when grown upon agar with decreasing concentrations of potato. Varying amounts of potato decoction, made as previously, were made up to 100 cc. with distilled water, and 2 per cent agar added. Two petri dishes were used for each food concentration for each strain. A second series was repeated at the critical points. The results are given in table II.

TABLE II
EFFECT OF QUANTITY OF FOOD UPON TYPE OF SPORANGIA

Potato decoction				
Per cent concentration	Strain A		Strain X	
	Per cent sporangia	Per cent sporangiola	Per cent sporangia	Per cent sporangiola
0.0	50	50	100	0
0.1-1.0	50	50	100	0
1.0-13.0	50	50	100	0
14.0	50	50	90	10
20.	50	50	100	0
40.	40	60	85	15
60.	30	70	70	30
90.	30	70	70	30
Potato-dextrose solution				
0.5	50	50	100	0
1-3	40	60	100	0
5-7	40	60	85	15
10	30	70	85	15
20-100	30	70	70	30

On both media Strain X produced only sporangia with poor food supply. Strain A never produced sporangia alone, although in media with low food supply there were relatively more sporangia and fewer sporangiola. The sporangia produced by both strains with low food concentrations were much smaller than those produced with greater food supply. Most of the sporangia produced upon potato agar between concentrations of 0.5 and 5 per cent were 10–16 μ in diameter and contained from 10 to 20 spores (pl. 25, fig. 7). Sporangia produced between 10 and 100 per cent concentrations were largely 40–80 μ in diameter and contained 50–100 spores (pl. 25, fig. 10). Upon the potato-dextrose agar between concentrations of 0.5 and 10 per cent the sporangia were 10–16 μ in diameter with 10–20 spores. Above 10 per cent they were 40–80 μ in diameter and contained 50–100 spores.

The concentration of the food also had its effect upon the sporangiola.¹ Between concentrations 0.5 and 5 per cent of potato agar and 0.5 and 2 per cent of potato-dextrose agar there was a predominance of solitary sporangioliferous heads. There were also sporangiola borne upon 2 sporangioliferous heads and a few upon 3 and 4 heads (pl. 25, figs. 1–4). As the amount of food increased, the sporangioliferous heads increased in number until there were as many as 20–30 in the higher concentrations of the two kinds of media (see pl. 25, fig. 5).

As the concentration of food increased the mycelium became more copious, particularly in the case of Strain X. After 70 hours this strain developed a dense mycelium covering the whole petri dish. In the aerial mycelium sporangia 10–16 μ in diameter began to develop and were very numerous in 4 days. This same type of sporangia appeared with Strain A but de-

¹ Cunningham states concerning the conidial fructifications of *Choanephora Cunninghamiana*: "In cases in which nutrition is imperfect, only a small number of capitella are produced and filaments are encountered with numbers diminished through various degrees until we find specimens with only two capitella. The process of abortion doesn't, however, reach its climax here; for a further stage occurs in which no capitella are produced, and in which the dilated extremity of filament gives direct origin to the sterigmata."

velopment was much slower, from 6 days to 2 weeks being required for a rich growth of aerial sporangia to develop.

Cultures of potato-dextrose agar with good mycelial development were autoclaved, cooled, and reinoculated. After 48 hours, fruiting appeared. In Strain A an equal number of both types of sporangia were produced. Most of the sporangia were borne upon the solitary sporangioliferous heads (pl. 25, fig. 1). The sporangia were of the small size. Strain X produced no sporangia and only small sporangia (pl. 25, fig. 7). Mycelium was scant in both strains. Apparently no toxic products of metabolism which inhibit growth were produced, since the results were practically the same as in the small concentrations of nutrient. Warm agar was poured over 6-day-old colonies of Strain A and Strain X grown upon potato-dextrose agar. In 48 hours fruiting appeared in both strains. The results were the same as in the killed cultures. The experiment was repeated with 1, 2 and 5 per cent potato agar with practically the same results. On media with a minimum of food supply, Strain A produced both types of sporangia while Strain X produced one type only.

A final experiment was tried to test the effect of poor nourishment upon the distribution of sporangial types. A piece of mycelium, 1 mm. in length and 3 months old, was transferred to a petri dish containing agar. Other pieces of similar mycelia were transferred to potato-dextrose agar. Fruiting appeared in 48 hours upon the potato dextrose and in 72 hours upon the agar.

TABLE III
EFFECT OF NOURISHMENT UPON TYPE OF SPORANGIA

Medium	Strain A		Strain X	
	Per cent sporangia	Per cent sporangiola	Per cent sporangia	Per cent sporangiola
Potato dextrose (10 dishes)	35	65	85	15
5 cc. potato broth (10 dishes)	50	50	100	0
Agar (10 dishes)	95	5	100	0

The above table shows the importance of nourishment and its effect upon the type of sporangia produced. Thus in Strain A, it was possible to obtain almost 100 per cent sporangia with very poor nourishment. A single spore culture upon agar-agar produced the same distribution of sporangial types as the piece of mycelium.

EFFECT OF HUMIDITY AND OF MOISTURE IN SUBSTRATE

On potato-dextrose agar the fungus produced a predominance of sporangiola about the edge of the petri dishes. This suggested that a dry substrate might help in the production of sporangiola. The dryness was obtained experimentally by varying the amounts of agar.

Strain A was planted on potato-dextrose agar, the concentration of agar in the media being 0.7, 0.9, 1, 1.2, 1.5, 2, 3, 4, 5, 6 per cent. As the concentration increased, the mycelium became heavier and more matted. The distribution of sporangial types was not affected between agar concentrations 0.7 and 3 per cent. The media containing 5 and 6 per cent agar had very much mycelium, but there was a little less than the usual quantity of sporangiola about the edge of the dish. There were numerous sporangia of the smaller dimension ($10-16\ \mu$) in the aerial mycelium on the petri dishes containing the higher concentrations of agar (5-6 per cent). These experiments were repeated, using two petri dishes for each concentration of agar. The same procedure was followed with Strain X, and here also the growth of mycelium was greater upon the media containing 2 to 6 per cent agar. In the 3, 4, 5, and 6 per cent agar concentrations the mycelium was unusually dense, with a preponderance of sporangia almost entirely in the aerial portion. Only a few sporangiola (4-5 per petri dish) were found in these higher agar concentrations.

The above experiments were repeated with the same series of concentrations of agar in potato decoction. The potato decoction was diluted (1 and 2 cc. solution to 100 cc. distilled water) and made up with the same series of agar concentrations. The results for both strains were the same as in potato-dextrose agar. The distribution of sporangial types remained the same

on the dry media as on the moist—for Strain A about 60 per cent sporangiola to 40 per cent sporangia and for Strain X only sporangia. It was noticed upon the drier substrates that the sporangia and sporangiola were borne upon sporangiophores about 5 mm. longer than the normal ones.

Finally a dilute potato broth (5 cc. potato decoction in 100 cc. distilled water) with the same agar concentrations was used. The distribution of sporangia and sporangiola was not affected, Strain A having 50 per cent of each and Strain X only sporangia. Both strains were then grown upon liquid potato decoction, and fruiting appeared in two days in both. Strain X in 20 tubes produced all sporangia, while Strain A produced 70 per cent sporangiola and 30 per cent sporangia.

The two strains were then grown in different humidities, the procedure of N. Stevens ('16) being followed. Large jars which could be sealed were used as containers. The petri dishes with lids removed were placed in the jars and the jars incubated at 20° C. The media used were potato-dextrose agar and potato agar (5 cc. potato decoction to 100 cc. water). Both strains were grown in the following humidities: 100, 90, 80, 70, 60, 42, 21.5, 10.5 and 2.5 per cent. The distribution of sporangial types was not affected in either strain grown in the range of humidity between 100 and 21.5 per cent. At 10.5 and 2.5 per cent, Strain A showed a slight increase in the number of sporangiola, but this increase was too slight to be of real significance; Strain X was not affected. The strains were also grown in very moist agar in the jar at 100 per cent humidity, without effect upon the distribution; nor was there any difference in distribution when the two strains were grown upon 7 per cent potato agar at 2.5 per cent humidity.

These results in general agree with Bachmann's ('95) prediction that humidity has very little effect upon the production of different sporangial types. However, in growth upon liquid potato broth, sporangia only were produced in Strain X. When this broth was solidified by the addition of agar, the usual distribution occurred, 90 per cent sporangia, 10 per cent sporangiola. Strain A did not behave in this manner.

EFFECT OF BASIC FUCHSIN

Since growth was rather much restricted for both strains upon Endo's agar, it was thought that the basic fuchsin present in the media might be the cause. In order to see whether such an inhibitor of growth would influence the distribution of sporangial types potato-dextrose agar and potato agar were prepared containing varying amounts of basic fuchsin.

The potato broth was made up by mixing 5 cc. of potato decoction with 100 cc. of water and solidifying with 2 gms. of agar. Basic fuchsin was then added in amounts ranging from .0001 to .01 per cent. At .01 per cent basic fuchsin there was no growth, but as the amount was decreased mycelial growth became more abundant. Fructification did not appear until 72 hours after inoculation. Many of the sporangia and sporangiola did not mature during the whole life of the colony, that is, they remained white throughout their life period. This was especially true when the potato agar contained .005, .004, and .003 per cent basic fuchsin. As far as distribution of sporangial types was concerned, there was only a slight increase in the number of sporangiola in Strain A where the higher concentrations of basic fuchsin were used. With Strain X, the distribution did not seem to be influenced at all, for 100 per cent sporangia was produced, the usual type of fructification when 5 cc. potato solution is used. This experiment was repeated, and two petri dishes were used for each basic fuchsin concentration for both strains. Potato dextrose was next used, the basic fuchsin varying from .0001 to .025 per cent concentration. Strain X did not grow when the dye concentration was .025 per cent, but with the lower concentration the phenomena mentioned above were also observed. There was the same slight increase in sporangiola number for both strains. Mycelial growth was also restricted and the fructifications took much longer to mature, some never maturing. In conclusion, it may be stated that making conditions unfavorable for growth and fruiting by introducing a dye, basic fuchsin, into the substrate does not seem to have any marked effect upon the distribution of sporangial types in either strain.

EFFECT OF INCUBATION TEMPERATURE

The two strains were inoculated upon potato-dextrose agar and incubated at different temperatures. At 6° C. there was no growth, but at 22° C. normal growth began and the usual types of sporangia resulted in both strains. Low temperature merely suspends activity. The optimum temperature was between 18° C. and 22° C. Between 28° and 36° C., the distribution of sporangial types was not affected but there was a slight increase in mycelium. At 34–36° C. there was very little fructification. When the fungi were incubated at 37° C. only mycelium was produced and at 40° C. there was no growth. The temperature at which strains are incubated seems to have no effect upon the distribution of sporangial types.

EFFECT OF EXPOSURE OF SPORES TO HIGH TEMPERATURES

The procedure followed in this experiment was similar to that of Barnes ('35) who worked with *Thamnidium elegans*. With a pipette, 0.5 cc. of a spore suspension of both strains was transferred to many tubes. These tubes were exposed to various high temperatures for different time intervals. Two petri dishes were inoculated for each high-temperature exposure for both strains. The whole experiment was performed twice.

The following are temperatures and time intervals at which the strains were exposed:

45° C.—1 min., 2 min., 5 min., 10 min., 1 hour, 2 hours.

50° C.—1 min., 2 min., 5 min., 10 min., 1 hour, 2 hours.

55° C.—1 min., 2 min., 5 min., 10 min.

60° C.—1 min., 2 min., 5 min., 10 min., 20 min., 30 min.

65° C.—1 min., 2 min., 5 min., 10 min., 15 min., 20 min.

70° C.—1 min., 2 min., 5 min., 10 min., 15 min., 30 min.

75° C.—1 min., 2 min., 5 min., 10 min., 15 min., 30 min.

80° C.—1 min., 2 min.

90° C.—15 sec.

100° C.—5 sec., 15 sec.

The spores were killed at 80° C. when exposed for one minute. The distribution of sporangial types was not at all affected in either strain by an exposure to high temperature. The only noticeable effect was a retardation in growth and the appear-

ance of fructification at 72 hours instead of the customary 48 hours when the spores were heated at 55° C. and above. Barnes ('35) found that spores of *Thamnidium elegans* yielded variant cultures after exposure to moderately high temperatures, and that the variants preserved their distinguishing characters through a considerable number of transfers. She does not mention whether the high temperature influenced the distribution of sporangia and sporangiola.

Frozen spores were thawed out and inoculated upon potato dextrose and incubated at the optimum temperature. Freezing apparently had no effect upon the distribution of sporangial types.

EFFECT OF LIGHT

The two strains were incubated in total darkness and in the light produced by a 60-watt lamp. The distribution of sporangial types was not affected. Light seems to be a stimulus for mycelial growth because those petri dishes in the light always produced much more mycelium than those in the dark.

EFFECT OF HYDROGEN-ION CONCENTRATION

Both strains grew best upon slightly acid media. The potato-dextrose agar has a pH of 5.4, and potato agar varied between 5.4 and 5.7. Other media used had various hydrogen-ion concentrations: bacto-malt-extract agar 4.6, potato-dextrose agar 5.4, nutrient caseinate agar 6.5, nutrient agar 6.6, eosine methylene-blue agar and yeast-dextrose agar 7.0, Endo's agar 7.52, bacto brain-veal agar 7.6. The distribution of sporangial types was not affected except on Endo's agar and peptone agar where other factors than hydrogen-ion concentration probably produced the results.

Potato dextrose was then made up with varying amounts of molar potassium hydroxide, and the pH measured by the glass electrode method. The hydrogen-ion concentrations studied were 5.6, 6.2, 7.3, 8.7, 9.6 and 10.2. The distribution of sporangial types was not at all affected by the hydrogen-ion concentration. Neither strain grew upon the media which has a pH of 10.2. At pH 9.6 growth was somewhat restricted, that is, there was less mycelium, but the distribution of sporangia

or sporangiola was not markedly changed. At a pH of 9.6 in Strain X there was a slight increase in sporangiola. Instead of the usual distribution, which is about 70 per cent sporangia and 30 per cent sporangiola, there was about an equal number of both types of fruiting bodies. It should be remembered that Endo's agar has a pH of 7.52, which is slightly on the basic side. Upon that agar there were more sporangiola than upon potato-dextrose agar. The slightly alkaline pH might play a slight role. A medium definitely upon the acid side, as bacto-malt-extract agar with a pH of 4.6, has no effect upon the distribution of sporangial types.

SUMMARY

1. Two strains of *Blakeslea trispora* reacted differently to various environmental stimuli. At times, they were so different in growth reactions that it was a temptation to separate the two strains as distinct species.

2. The kind of medium did not seem to have any marked effect upon the distribution of sporangial types, except Endo's agar and peptone agar with Strain A. The formation of sporangiola was favored by these media.

3. The quantity of the food has the most direct influence upon the distribution of sporangial types. With poor nourishment Strain X produced only sporangia. With richer food or with addition of various sugars to potato agar, the sporangiola began to appear. With Strain A it was never possible to obtain one type of reproductive structure to the exclusion of the other—even when agar alone was used. Here the distribution of reproductive structures was half sporangia and half sporangiola. When a tiny piece of mycelium was planted upon agar, there was 95 per cent sporangia to 5 per cent sporangiola. In general, media poor in nutrients favor sporangial formation while those rich in nutrients favor sporangiole formation.

The various other stimuli tried—humidity, moisture content of the substrate, light, hydrogen-ion concentration, freezing and heating of spores, prolonged soaking of spores in distilled water, various methods of inoculation, various incubation temperatures, and frequent transplantation—had no effect upon the distribution of sporangial types. The extent of mycelial

growth and pigmentation were affected by some of these stimuli. In general, the most important factor which determines the type of sporangial fructification is the quantity of food, all other environmental factors mentioned playing a relatively minor role.

This work was done at the suggestion and under the supervision of Professor Carroll W. Dodge in the Henry Shaw School of Botany of Washington University. The writer is greatly indebted to Professor Dodge for many helpful suggestions during the course of the experiments. Also, it is a pleasant duty to acknowledge the help in experimental procedures rendered him by his classmate, Alexander Horwitz.

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EXPLANATION OF PLATE

PLATE 25

Blakeslea trispora Thaxter.

Figs. 1-4. Sporangioliferous heads produced under conditions of poor nourishment. $\times 140$.

Fig. 5. Fructification produced under conditions of abundant nourishment. $\times 140$.

Fig. 6. Spore showing cluster of delicate radiating appendages. $\times 900$.

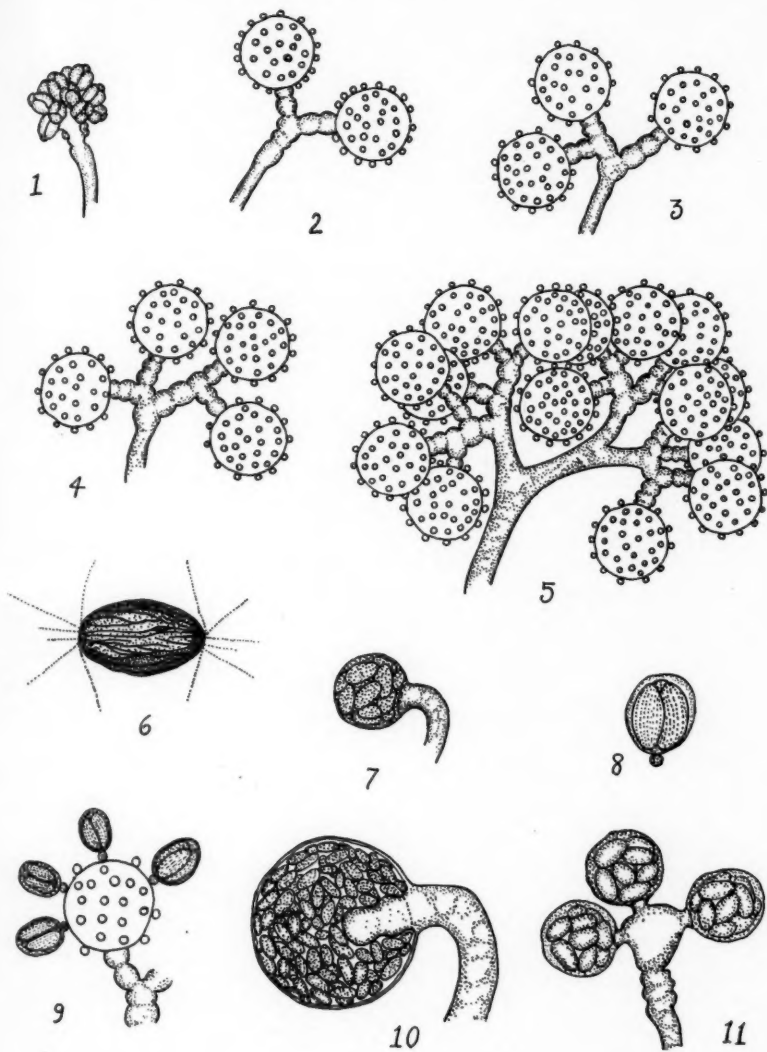
Fig. 7. Smaller type of sporangium with no columella. $\times 350$.

Fig. 8. Typical sporangiolum with three spores showing small spherical vesicle which attaches the sporangiolum to the sporangioliferous head. $\times 490$.

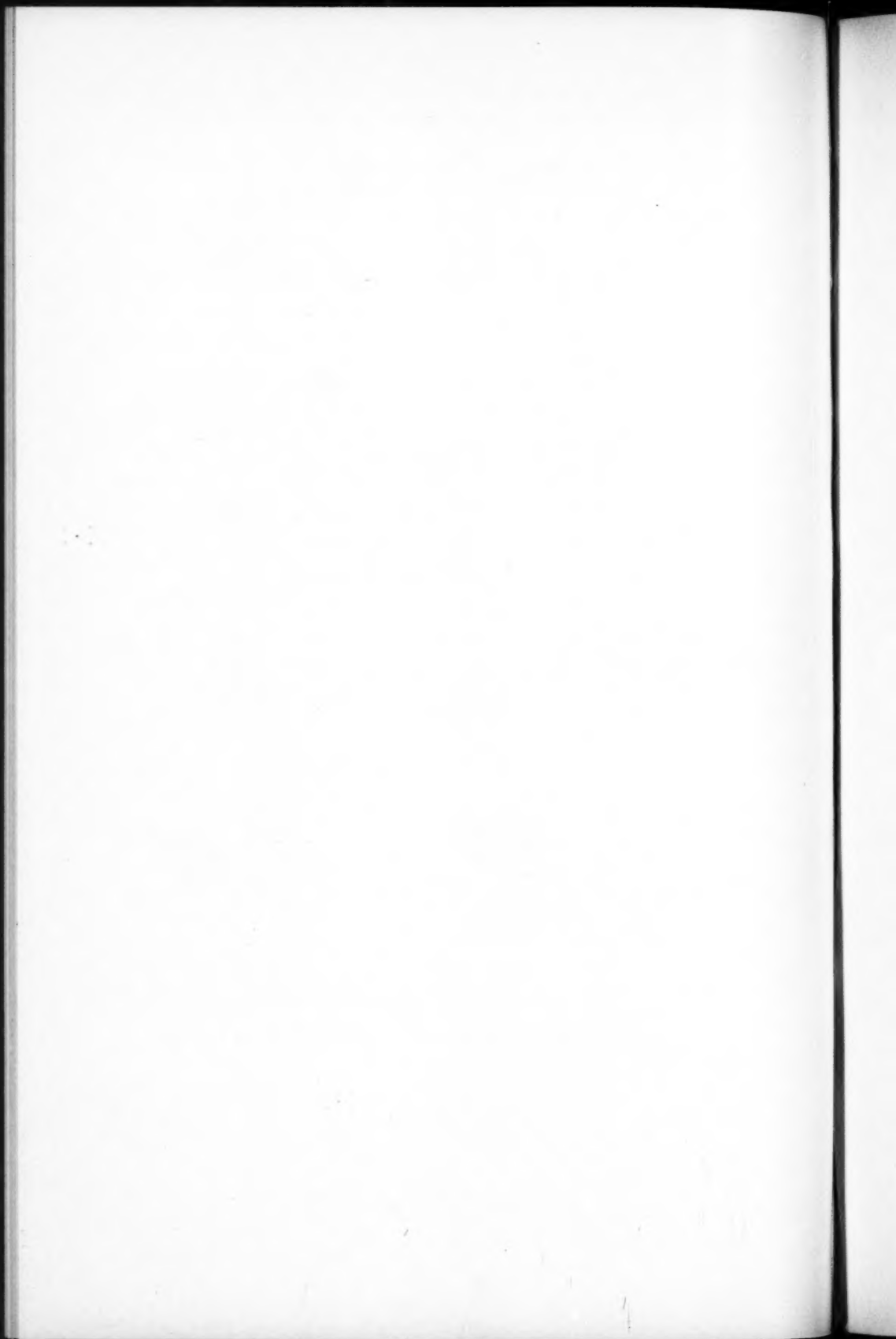
Fig. 9. Sporangioliferous head with adhering sporangiola. $\times 250$.

Fig. 10. Larger type of sporangium with columella. $\times 250$.

Fig. 11. Type of sporangium figured by Thaxter but never observed by the writer, which greatly resembles the sporangiolar type of fructification. $\times 240$.



GOLDRING—BLAKESLEA TRISPORA



NEW ORGANISMS OF CHROMOMYCOSIS¹

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The organisms of the disease chromomycosis (chromoblastomycosis of Terra, Torres, da Fonseca & Arêa de Leão), or dermatitis verrucosa, have received little comparative study. Except for the recent investigations of Carrión and Emmons, no attempts have been made to point out definite morphological relationships among these microbes. The only well-established fungus of the group is *Phialophora verrucosa* Thaxter, which has been isolated only twice in the United States and once in Uruguay. Another organism treated in several publications, *Acrotheca Pedrosoi*, is the only agent of chromomycosis of South America, according to a number of mycologists. A Brazilian pathogen from this disease, studied by French workers, was first named *Hormodendron Pedrosoi* Brumpt, and later the name was changed to *Trichosporium Pedrosianum* by Ota, and then to *T. Pedrosoi* by Langeron. This microbe, considered to be identical with other Brazilian fungi causing chromomycosis, has led to some taxonomic confusion.

While in São Paulo, Brasil, the opportunity was presented to make a comparative study of a number of cultures of fungi isolated from cases of chromomycosis in South America and in North America, in the laboratory of the junior author. As a result of an intensive examination of these pathogens, the fol-

¹ Work made possible through a fellowship granted by the John Simon Guggenheim Memorial Foundation to the senior author, for study in South America, 1935-1936.

lowing conclusions were arrived at: First, *Phialophora*, as described by Thaxter, not only exists in South America, as was pointed out by MacKinnon in Uruguay, but an original strain studied by Pedroso and Gomes (named *P. verrucosa* by these workers and then changed to *Acrotheca Pedrosoi* by other South American investigators) was found to be a new species, *Phialophora macrospora*. Second, *Hormodendron Pedrosoi* Brumpt (*Trichosporium Pedrosoi* Langeron) shows sufficient characters other than those of the genus *Hormodendron* to form a new genus, *Hormodendroides*, with *H. Pedrosoi* as the type species. Third, *Gomphinarina Pedrosoi* (Brumpt) Dodge (*Acrotheca Pedrosoi* of Terra, Torres, da Fonseca & Leão), an organism which was considered identical with *Hormodendron Pedrosoi*, was found to have characteristics simulating those of the genus *Botrytis* and also certain features not belonging to that genus. For these reasons the genus *Botrytoides* is described as new, but since *Pedrosoi* is the specific name for the type species of *Hormodendroides* the name *monophora* is given to the type species of the new genus. Fourth, an organism isolated in Brasil from a case of chromomycosis has the characteristics of all the above genera: the "cup" formation common to *Phialophora*, the conidiophores common to *Botrytoides*, *Hormodendroides*, and *Hormodendron*, in addition to the superimposition of the "cup" formation on the *Hormodendron* conidiophores. This fungus is here described as a new genus, *Phialoconidiophora*. It is given the specific name of *P. Guggenheimia* in honor of the Foundation which made the work possible. The organism *Hormodendron compactum* Carrión is no doubt of this same genus, but differs sufficiently in cultural features and mycelial measurements to be a new species, *Phialoconidiophora compactum* (Carrión) Moore & Almeida, n. comb.

Although not entirely in favor of establishing a number of new genera for a group of organisms which show close relationships in certain aspects, yet the authors feel that the so-called "lumping" or grouping of several distinctly different microbes in the same genus adds only to the existing confusion in the taxonomy. Hence the following new genera are de-

scribed provisionally until a mycological classification is established which will allow for a taxonomic differentiation of such organisms.

The fungi are here described with English and Latin diagnoses. A more complete and illustrated discussion will follow in a later publication.

Phialophora macrospora Moore & Almeida, sp. nov.

Phialophora verrucosa A. Pedroso & J. M. Gomes, Bull. Soc. Med. Cir. São Paulo 3: 254. 1920; Gomes, *ibid.* 3: 42, 43. 1920; Ann. Paulistas Med. Cir. 11: 53-61. 1920. *Acrotheca Pedrosoi* Terra, Torres, da Fonseca & Arêa de Leão, Brasil Medico 2: 363-368. 1922.

This species differs from *P. verrucosa* in the size of the spores and "cups." Spores large, spherical, ovoid or ellipsoid, elongate or short, variable in form and size; spherical up to 7 μ in diameter, ellipsoid 2-4 \times 3-7 μ . Hyphae branched, septate, 2-6 μ in diameter. Spore-bearing cups 2-7 μ in diameter at lips, chiefly 4-5 μ . Oidoid cells approximately 5 μ in diameter. Spherical cells on Loeffler's agar 6-14 μ in diameter, usually 12 μ . Color of colonies grayish-brown, olivaceous-green to black.

Differt ab *P. verrucosa* in magnitudine sporarum phialarumque. Sporae magnae, multifformes, sphaericae, ovoideae vel ellipsoideae, elongatae vel breves; sphaericae ad 7 μ diametro; ellipsoideae 2-4 \times 3-7 μ . Hyphae ramosae, septatae, 2-6 μ diametro. Phialae 2-7 μ diametro ad labias, plerumque 4-5 μ . Oidia circiter 5 μ diametro. Cellulae sphaericae in "Loeffler's agar" 6-14 μ diametro, plerumque 12 μ . Color "grayish-brown," "olivaceous green" vel nigrum.

Botrytoides Moore & Almeida, gen. nov.

Simulates *Botrytis* morphologically but differs in the blue-black color of culture. Hyphae repent, branched, septate, submerged on most substrates. Conidiophores simple or branched or proliferating, brown with simple, irregular tips due to presence of small continuations of conidia (sterigmata of some authors) which remain after conidia mature and separate from conidiophore. Conidia fusiform to short-cylindric,

several attached close together at the tip of the conidiophore, brown or subhyaline in color.

Hoc genus *Botrytidi* similis, differt in culturis atris. Hyphae repentes, ramosae, septatae, plerumque submersae. Conidiophorae simplices vel ramosae proliferantesve, fulvae, simplicibus irregularibusque cum apicibus, sterigmatibus minutis persistentibus tectis. Conidia fusiformia aut brevia, cylindrica, catervatim plerumque apicalia, fulva vel subhyalina.

The genus *Campsotrichum*, generally considered to be a dematiaceous *Botrytis*, is to be differentiated from *Botrytoides* on the basis of conidiophore morphology and spore distribution. The conidiophores of *Campsotrichum* terminate in short, bifurcated branches with the spores arranged on short branchlets, as contrasted with the simple or branched conidiophores of *Botrytoides*.

The type species of this genus is:

***Botrytoides monophora* Moore & Almeida, sp. nov.**

Phialophora verrucosa A. Pedroso & J. M. Gomes, Bull. Soc. Med. Cir. São Paulo 3: 254. 1920; Gomes, *ibid.* 3-42, 43. 1920; Ann. Paulistas Med. Cir. 11: 53-61. 1920. *Hormodendron Pedrosoi* Brumpt, Précis Parasitol. ed. 3. 1921.

Acrotheca Pedrosoi Terra, Torres, da Fonseca & Arêa de Leão, Brasil Medico 2: 363-368. 1922.

Trichosporium Pedrosianum Ota, Jap. Jour. Derm. Urol. 28⁴: 6. 1928. (In Emmons, 381-423, Abs. in Fr. 16-23.)

Trichosporium Pedrosoi Langeron, Ann. Parasitol. Hum. Comp. 7: 145-150. 1929.

Gomphinaria Pedrosoi Dodge, Med. Myc. p. 850. 1935.

Colonies dark, greenish-gray, olivaceous-green to black with a brown or purple tinge. Conidiophores single or multicelled, lateral or terminal. Spores ovoid, ellipsoid, or subfusiform, $1\frac{1}{2}$ -5 \times 2-8 μ , arranged along the conidiophore or in head formation. Hyphae of regular, irregular, or sclerotic cells, 2-5 μ in diameter, depending on medium grown.

Culturae obscurae, viridi-cinereae, "olivaceous-green" vel nigrae, fulvescentes purpurascentesve. Conidiophorae uni- aut multi-cellulae, laterales aut terminales. Sporae ovoideae, ellipsoideae aut subfusiformes, $1\frac{1}{2}$ – 5×2 – 8μ diametro, in conidiophoris aut in capitibus dispositae. Cellulae hypharum regulares aut irregulares aut scleroticae, 2 – 5μ in mediis diversis.

Hormodendroides Moore & Almeida, gen. nov.

Mycelium black, septate, branched. Conidiophores of two types: simple with conidia fusiform to short-cylindric, several attached on irregular, thickened, terminal portion of conidiophore; and conidiophores of *Hormodendron* type with spores catenulate in acrogenous branches, subspherical or ellipsoid.

Mycelium nigrum, septatum, ramosum. Conidiophorae biformes: (1) simplices, conidiis pyriformibus vel breve-cylindricis, aliquot in irregulare crassata terminale parte conidiophorae junctis; (2) ramosae *Hormodendro* similes, sporis catenulatis, acrogenis, subsphericis aut ellipsoideis.

The type species is *Hormodendron Pedrosoi* Brumpt.

Hormodendroides Pedrosoi (Brumpt) Moore & Almeida, comb. nov.

Hormodendron Pedrosoi Brumpt, Précis Parasitol. ed. 3. 1921.

Acrotheca Pedrosoi Terra, Torres, da Fonseca & Arêa de Leão, Brasil Medico 2: 363–368. 1922.

Trichosporium Pedrosianum Ota, Jap. Jour. Derm. Urol. 28⁴: 6. 1928.

Trichosporium Pedrosoi Langeron, Ann. Parasitol. Hum. Comp. 7: 145–150. 1929.

Gomphinarina Pedrosoi Dodge, Med. Myc. p. 850. 1935.

Phialoconidiophora Moore & Almeida, gen. nov.

This genus differs from *Phialophora* by the presence on various media of the three types of conidiophores: dendroid, branching conidiophores of the *Hormodendron* type, with "cupulliform" spore-bearers generally produced at the apices of the "conidiophores," but sometimes laterally; and conidiophores of the *Botrytoides* type; and also by the "cupulli-

form" spore bearers of the *Phialophora* type. Cells (chlamydospores) of the type seen in tissue. Spores from "cups" globoid to ovoid, small, hyaline to subhyaline and held together by a mucilaginous substance; spores from conidiophores of *Botrytoides* type ovoid, ellipsoid, or subfusiform, larger than the above; spores of *Hormodendron* type catenulate in acrogenous branches, subspherical or ovoid. Hyphae branched and septate.

In mediis diversis hoc genus differt ab *Phialophora* in conidiophoris dendroideis ramosis, *Hormodendro* similibus, et phialis plerumque apicalibus vel aliquot lateralibus; et conidiophoris *Botrytoidi* similibus; et sporophoris phialidis *Phialophorae* similibus. Cellulae (chlamydosporae) eis in hospite similes. Sporae ab phialis globoideae vel ovoideae, parvae, hyalinae vel subhyalinae, materia mucilaginosa cohaesae; sporae conidiophoris *Botrytoidi* similibus ovoideae, ellipsoideae vel subfusiformes, maiores quam eae in *Botrytoidi*; sporae *Hormodendro* similes catenulatae in ramis acrogenis, subsphaericae vel ovoideae. Hyphae ramosae et septatae.

The type species of the genus is:

***Phialoconidiophora Guggenheimia* Moore & Almeida, sp. nov.**

Mycelium aerial or submerged. Cultures olivaceous-green, grayish-black tinged with purple or black. Hyphae $2-4\frac{1}{2}$ μ in diameter, bearing conidia $1\frac{1}{2}-4\frac{1}{2} \times 3-8$ μ , sessile, single and isolated, or on short to long, single or multicelled, warty conidiophores, simple, branched, or proliferating, of *Botrytoides* type. Conidiophores of *Hormodendron* type with smooth to warty "foot cells" of various proportions, bearing several phialides approximately $2-4 \times 4-10$ μ , with conidia $1\frac{1}{2}-4\frac{1}{2} \times 3-8$ μ . Phialae $2-6$ μ in diameter at lips, borne either on specialized branches or developing directly from hyphae or on stalks, one to several-celled; spores mostly hyaline, globoid $1-3$ μ in diameter, ovoid $1-2\frac{1}{2} \times 2-4$ μ . Oidioid cells $4-7$ μ in diameter or long axis. Bundles of hyphae (coremioid) with hyphae $2-3\frac{1}{2}$ μ in diameter. Sclerotic cells of various proportions. Chlamydospores thick-walled, single or multilocular, approximately $3-16 \times 3-16$ μ , some larger on various media.

Mycelium aerium aut submersum. Culturae "olivaceous green," "grayish black" purpurascens vel nigrescentes. Hyphae $2-4\frac{1}{2}$ μ diametro. Conidia $1\frac{1}{2}-4\frac{1}{2} \times 3-8$ μ , sessilia, singula aut in conidiophoris multicellulis verrucosis simplicibus ramosis aut proliferantibus *Botrytoidi* similibus. Conidiophorae *Hormodendro* similes cellulis basalibus laevibus vel verrucosis, diversae magnitudine, phialides circiter $2-4 \times 4-10$ μ ferentae, cum conidiis $1\frac{1}{2}-4\frac{1}{2} \times 3-8$ μ . Phialae $2-6$ μ diametro ad labias, sessiles, in conidiophoris aut in stipibus, uni aut pluri-cellulae. Sporae subhyalinae vel plerumque hyalinae, globoideae, $1-3$ μ diametro, ovoideae $1-2\frac{1}{2} \times 2-4$ μ . Oidia $4-7$ μ diametro in axe longo. Hyphae in fasciculis $2-3\frac{1}{2}$ μ diametro. Cellulae scleroticae diversae magnitudine. Chlamydo-sporae cum muris crassis, singulae, multiloculatae, $3-16 \times 3-16$ μ , aliquando maiora in mediis diversis.

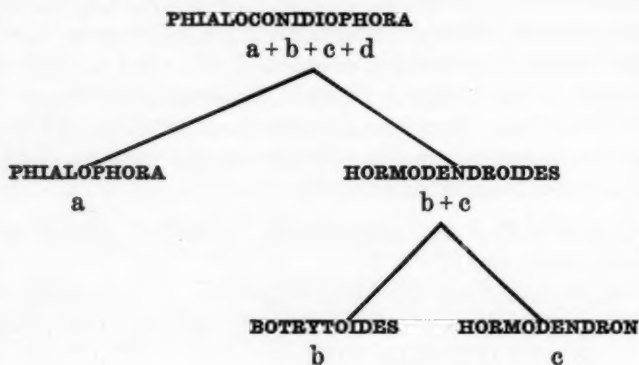
Phialoconidiophora compactum (Carrión) Moore & Almeida, comb. nov.

Hormodendrum compactum Carrión. A. L. Carrión, Puerto Rico Jour. Publ. Health 10: 543-545. 1935; *ibid* 11: 663-681 (679-681). 1936.

Hyphae long, coarse, $2.5-5.2$ μ , arborescent, with occasional dichotomous branching. *Hormodendron* sporulation predominant; *Phialophora* type rare. Conidia in former spherical or subspherical, smooth, olivaceous, borne in short branching chains, in compact groups at tip of conidiophores, $2.5-4.8 \times 2.5-3.8$ μ . Basal elements in chains $3.8-6 \times 3-4.5$ μ . Conidiophore of *Phialophora* type $7-12 \times 3-4$ μ . Conidia $1.5-2 \times 2-3$ μ , oval, smooth, thin-walled and light green in color. Growth on Sabouraud's agar slow, colonies 2.5 cm. in diameter after 6 weeks. Abundance of aerial hyphae, amber in color. Colonies on 4 per cent dextrose agar similar except for a smoother, more velvety appearance. Colony on Czapek's agar poorly developed, with a diameter of 10-16 mm. at end of 6 weeks. Mycelium in substrate olive-black.

The generic relationship in question here can be brought out more clearly if the phylogeny is considered speculatively. Assuming that the organism with the most complicated life cycle

is the oldest, and the simplest the youngest, then we can trace a direct descendance of one group from another. If we let "a" represent the "cup" formation of *Phialophora*; "b" the conidiophores of *Botrytoides*; "c" the conidiophore of *Hormodendron*; and, "d" the compound formation of the "cup" formation of *Phialophora* superimposed, as it were, on the conidiophore of *Hormodendron*, then the schematic arrangement is greatly simplified as follows:

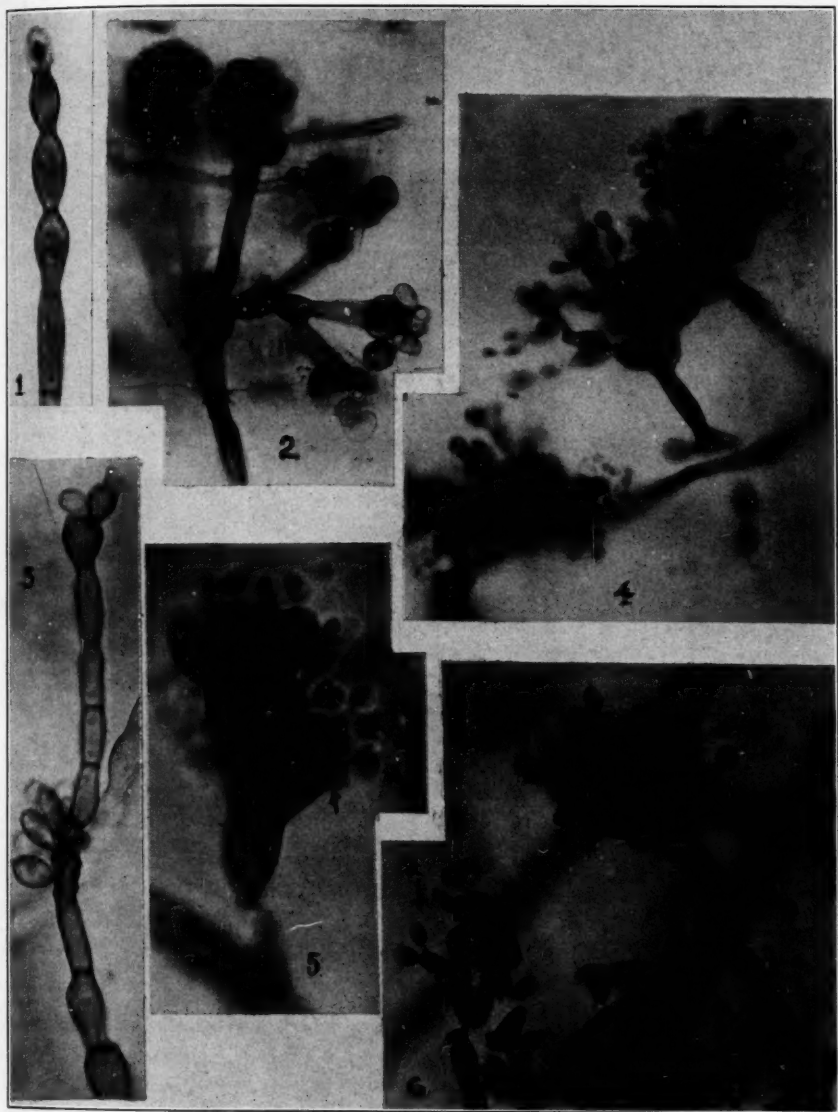


NOTE. Since this paper went to press the authors have found that Bonorden spelled the genus name *Hormodendrum* and not *Hormodendron* as they and most medical mycologists have given it. The spelling should be changed throughout this paper.

EXPLANATION OF PLATE

PLATE 26

- Fig. 1. "Conidiophore" of *Phialophora macrospora* with emerging spore.
Fig. 2. "Conidiophores" of *P. macrospora* with groups of spores.
Fig. 3. Conidiophores of *Botrytoides monophora*.
Fig. 4. "Conidiophores" of *Phialoconidiophora Guggenheimia*, of *Hormodendron* type with cups of *Phialophora* type.
Fig. 5. Enlarged "conidiophore" showing "cupuliform" spore bearer.
Fig. 6. Mycelium of *P. Guggenheimia* showing: a. conidiophores of *Botrytoides* type. b. "cupuliform" spore bearer. c. *Hormodendron* type of spore formation. d. conidiophore of c.



MOORE & ALMEIDA—NEW ORGANISMS OF CHROMOMYCOSIS



NEW GENERA OF CLADOCHYTRIACEAE

GEORGE ZEBROWSKI

The thallophytes described in this paper are believed to be fungi belonging to the family Cladochytriaceae. They all possess a definite hyphal mycelium and either terminal, subterminal, or intercalary enlargements which frequently contain spores and assumedly are sporangia. The thalli proliferate within the limy matrix of Echinoderm spicules, shells of molluscs, and foraminifera, and within the spicules of calcareous sponges. The entire fungus is buried within the substrate and communicates with the exterior only by means of single pores which open into the sporangial sacs. All the described forms were found by the writer about two years ago in calcareous Australian sand associated with such fossils as *Globigerina*, *Textularia*, *Nodosaria*, *Lagena*, and *Spiroloculina*. Their age, therefore, may range from Cambrian to recent. The samples of sand were obtained from Ward's Natural Science Establishment, Rochester, N. Y., and were collected at Ninety Mile Beach in South Victoria, Australia.¹

¹ It is to be regretted that neither the collector of these fungi, nor their exact location could be determined. The labels accompanying the samples of sand merely stated "Ninety Mile Beach, South Victoria, Australia." The party collecting these sands has died, and no additional information was available. To clear up their origin, the writer dispatched an inquiry to Sir Douglas Mawson, at the University of Adelaide, which elicited the following reply:

"The locality 'Ninety Mile Beach, South Victoria,' is not specifically correct for either of the two Ninety Mile Beaches figuring on our maps. There is such a beach at Gippsland, Victoria, where it faces the Pacific Ocean. But there is another Ninety Mile Beach in South Australia which faces the Southern Ocean, and extends east from the mouth of the Murray River.

"I can't imagine how Wards got a sample from the South Australian Ninety Mile Beach and think it most likely that yours came from Gippsland. I will therefore get in touch with F. Chapman, Palaeontologist of the National Museum, Melbourne, who is an authority on foraminifera and much interested in marine sands. He may be able to get some Gippsland beach sand for you.

"As for our Ninety Mile Beach sand I will take the first opportunity to enlist the services of any scientists going that way—and hope to procure some for you. It is an out-of-the-way place, however, there being no settlement near that long line of coast."

The type and cotype specimens have been deposited in the herbarium of the Missouri Botanical Garden, St. Louis.

The writer acknowledges his indebtedness for aid and suggestions in carrying out this study to Dr. Charles Lyman Porter, of Purdue University, and Dr. Carroll William Dodge, of the Henry Shaw School of Botany of Washington University. The photomicrographs accompanying this article are partly the work of Dr. Edwin Jacob Kohl.

DODGELLA Zebrowski, gen. nov.

Hyphae intramaticales in ostracis, ex base spherica ramosae, perpendicularibus hyphis sporangiferis; dehiscentia ignota; sporangiosporae sphaericae.

Type: *Dodgella priscus* Zebrowski.

Hyphae rarely branched, growing beneath the surface of shells and in sponge spicules, proliferating from the spherical base of the sporangia which are subterminal with the longitudinal axis at right angles to the hyphae, dehiscence unknown; sporangial neck reaching surface of the shell or spicule and opening by a pore to the outside; sporangiospores ? spherical.

This genus is closest to *Nowakowskiella* and *Cladochytrium*, but the branching is different, also the attachment of the sporangium to the hypha. This genus is named in honor of Dr. Carroll W. Dodge.

Dodgella priscus Zebrowski, sp. nov. Pl. 27, figs. 1, 3.

Thallus sphericus, levis, 2-9 hyphas gignens; sporangia 15 μ diametro, cervix ad 5 μ longitudine, apertura apicale ad 3.5 μ diametro; sporangiosporae? rarae, sphaericae, brunneae?, ad 3 μ diametro.

Thallus a simple, smooth, globular sac, about 15 μ in diameter, from which emerge 2-9 distributive hyphae; sporangial necks short, about 5 μ long, communicating with the surface by a circular aperture about 3.5 μ in diameter; sacs usually empty, occasionally showing red or brown, spherical spores? averaging 3 μ in diameter.

This interesting fungus is of wide and seemingly cosmopolitan distribution. The writer found it in sands of both fossil

and recent formations from such widely separated localities as South China Sea, South Australia, Texas (Eocene formation), Africa, and from beach sands around Beaufort, North Carolina. The specimens from the different localities vary somewhat in size, but the variations are so slight that it has not been possible to resolve them into more than a single species. This species has been found growing on the shells of molluscs and ostracoda and within the spicules of sponges (pl. 27, fig. 3).

This fungus shows a tendency toward rapid proliferation and the formation of extensive colonies, being the most abundant species. The mature sac sends off one or more reproductive hyphae from its globular base. These grow for varying distances just below the surface of the substrate and eventually each hypha produces a new sac, subterminal in position and from 5 to 15 μ back from its tip. This daughter sac then grows down into the substrate at right angles to the hypha and in turn it produces new hyphae from its globular base. Occasionally sacs are also produced at the tips of hyphae. The hyphae are about 1 μ thick, of uniform diameter, and branch but rarely.

When spores were dissolved on a slide with dilute hydrochloric acid, those from a single sac remained cemented together in a clump, some degree of force being required to separate them with a dissecting needle. Further, spores similar to those within the sacs were found scattered over the surfaces of a number of pieces of shell. Most of these spore-like bodies not only adhered to the surface, but were embedded in spherical cavities of varying depths. It seems likely that the spores secrete some substance which enables them to adhere to the shells on which they may lodge and develop. Occasionally a hypha would end in a bifurcation consisting of two comma-shaped swellings, thickest at their free ends. It is possible that these are gametangia.

Dodgella inconstans Zebrowski, sp. nov. Pl. 27, fig. 2.

Hyphae 1 μ diametro, subramosae; sporangia 15–22 \times 27–44 μ , irregularia, subterminalia, ampulliformia, lobata, subapplanata, cervicibus perpendicularibus, ostiolis circularibus, 4 μ diametro.

Hyphae occasionally branched, $1\ \mu$ in diameter, sterile hyphae rare; young sporangia subterminal, flask-shaped, growing straight down into the substrate, the bottom soon becoming lobed or folded and usually somewhat flattened, so that the neck is at right angles to the venter, $15-22 \times 27-44\ \mu$; ostioles single, circular, averaging $4\ \mu$ in diameter; no spores seen. One large colony, however, showed the sporangia more or less completely filled with an amorphous, brown substance with black spots, resembling protoplasm.

On shells of molluscs in tidal beach sands, Beaufort, North Carolina, of recent origin.

The sporangia are extremely variable in size and shape in this species.

Dodgella radicans Zebrowski, sp. nov. Pl. 27, fig. 4.

Hyphae $1\ \mu$ diametro; sporangia $17-21 \times 27-43\ \mu$, subterminalia, pyriformia, ostiolis circularibus, $4\ \mu$ diametro, rhizoideis 4-15, plerumque 8, longitudine variabilibus, irregulariter sparsis; sporae non visae.

Hyphae of uniform diameter, about $1\ \mu$, usually 2 or 3 distributive hyphae and 4 to 15, usually 8 rhizoids to each sporangium; sporangia $17-21 \times 27-43\ \mu$, subterminal, pyriform, opening to the surface of the shell by a single circular ostiole about $4\ \mu$ in diameter; spores not seen.

In shells of molluscs in fossiliferous sands from Ninety Mile Beach, probably Victoria, Australia.

COULTERELLA Zebrowski, gen. nov.

Hyphae intramatrales praelongae, tenuissimae, in ostracis molluscorum; sporangia fusiformia vel bifurcata (literae Y similia); sporae pachydermaticae, sphaericae vel subsphaericae.

Type: *Coulterella Petersoni* Zebrowski.

Intramatrical hyphae very long, slender, in shells of molluscs; sporangia fusiform or forked (in a single plane similar to the letter Y); spores thick-walled, spherical or flattened, abundant.

This genus differs from the preceding in the shape of its spo-

rangia which are often forked and communicate with the surface by a common pore. The genus is named for Dr. Stanley Coulter.

Coulterella Petersoni Zebrowski, sp. nov. Pl. 27, fig. 12.

Hyphae 270–730 μ longitudine, aequales, ad 1 μ diametro; sporangia 68–98 \times 20–27 μ , simplicia fusiformiaque vel bifurcata (literae Y similia), poro singulo commune aperta, ad 5 μ diametro; sporangiosporae copiosae, subapplanatae, junioribus leptodermaticis, ad 5 μ diametro, maturis pachydermaticis, ad 4 μ diametro, rubro-brunneis.

Hyphae long, 270–730 μ , uniform in diameter, about 1 μ ; sporangia 68–98 \times 20–27 μ , either simple and fusiform or proliferating in a single plane to form Y-shaped structures opening to the surface by a common pore about 5 μ in diameter; sporangiospores abundant both in the primary sporangium and its branches, somewhat flattened, thin-walled, slightly greenish in appearance, 5 μ when young, becoming thick-walled, reddish, averaging about 4 μ in diameter when mature.

Found in shells of molluscs. This species is named in honor of Prof. Perry S. Peterson.

Coulterella Petersoni is a common form resembling *Conchyliastrum Enderi* in its development. The thallus is a flattened sac, with only 1–3 similarly flattened diverticula which usually give rise to two or more distributive hyphae. The diverticula or lateral sacs are more irregular in outline in this species than they are in *Conchyliastrum Enderi*; also, two or more hyphae may emerge from each diverticulum, which was never observed in *Conchyliastrum*, where the hyphae arise singly as distal prolongations of the lateral sacs. In both genera the daughter sacs are formed one to each hypha, usually sub-terminal in position. Each daughter sac then develops into a primary sac. Each primary sac in turn gives rise to one or more lateral pouches which lie in the same plane and appear to be only prolongations of the main sac; in *Conchyliastrum Enderi* the pouches are usually at an angle or at right angles to the main sac. When only one pouch develops, the resulting thallus is fusiform, but with two

pouches, the thallus is roughly Y-shaped (pl. 27, fig. 12). The daughter thalli remain attached to the parent by means of the distributive hyphae which occasionally branch. The numerous spores of this species were found closely packed both in the primary sacs and in the diverticula. Two kinds of spores were observed, a thick-walled, red spore averaging $4\ \mu$ in diameter, and a larger, thin-walled, greenish spore $5\ \mu$ in diameter. This last was assumed to be immature. Both types are somewhat flattened.

PARAMOECIELLA Zebrowski, gen. nov.

Hyphae longae, ramosae, ramis perpendicularibus; sporangia elongata intercalaria, somati *Paramoecii* similia, levia, leptodermatica; sporae non visae.

Type: *Paramoeciella Gamblei* Zebrowski.

Hyphae branched, alternate, rarely opposite, perpendicular to the axis of the main hypha, bearing large, intercalary, elongate sporangia, shaped like the body of *Paramoecium*, but smooth and thin-walled; spores not seen.

These large intercalary sporangia, shaped like the body of *Paramoecium*, seem quite distinct from any genus so far reported.

Paramoeciella Gamblei Zebrowski, sp. nov. Pl. 27, figs. 5-6.

Hyphae $7\ \mu$ diametro, longae, infrequenter ramosae, intramatrales; sporangia intercalaria, elongata, $193\text{--}214 \times 280\text{--}962\ \mu$, somati *Paramoecii* similia, sed levia, leptodermatica; sporae non visae.

Hyphae long, $7\ \mu$ in diameter, infrequently branched, usually alternate, rarely opposite, branches at right angles to the main axis, thickened at the base; sporangia intercalary, elongate, closely resembling *Paramoecium* in outline, $280\text{--}962 \times 193\text{--}214\ \mu$, each sporangium arising as an elongate swelling on one side of a hypha, with its long axis parallel to that of the main hypha and attached at its side for about one fourth its length; hyphae occasionally seen arising directly from the sporangium (pl. 27, fig. 6); large oval aperture averaging $34\ \mu$ in width and tapering toward the sac developing at the point of contact; en-

tire thallus smooth and thin-walled, without spines or other irregularities; no spores observed.

This species was quite common and usually occurred in clusters of sporangia and hyphae as shown in pl. 27, fig. 5. It is named for Dr. Dean La Fever Gamble.

ARTHURELLA Zebrowski, gen. nov.

Hyphae intramatrales; sporangia elongata, tubularia, terminalia, longis cum cervicibus, poris apicalibus, proliferantia; sporangia partialia, spherica vel pyriformia, irregulariter distributa; sporae in sporangiis lateralibus (partialibus), sphaericae.

Type: *Arthurella Corringtoni* Zebrowski.

Hyphae intramatrix; sporangia elongate, tubular, terminal with long tapering necks, opening by an apical pore, proliferating to form spherical or pyriform, partial sporangia irregularly distributed over the primary ones; spores spherical, seen only in the lateral (partial) sporangia.

The genus is named in honor of Dr. Joseph Charles Arthur.

Arthurella Corringtoni Zebrowski, sp. nov. Pl. 27, fig. 10.

Hyphae 3-4 μ diametro; sporangia elongata, tubularia, 48-119 \times 13-24 μ , terminalia, longis cum cervicibus, poris apicalibus 5 μ diametro, proliferantia; sporangia partialia spherica vel pyriformia, irregulariter distributa, magnitudine variabilia; sporangia magna una cum partialibus echinulata; sporae in sporangiis lateralibus (partialibus) aureae, sphaericae, 3 μ diametro.

Hyphae 3-4 μ in diameter, tapering only slightly, usually thickened at point of emergence, occasionally branched, arising only from main sporangium; sporangia 48-119 \times 13-24 μ , with long tapering necks and apical pores 5 μ in diameter, proliferating to form partial sporangia which are pyriform or spherical, irregularly distributed along the main sporangium, variable in size, perhaps produced progressively as the sporangium elongates; larger sporangia and portions of adjacent hyphae covered with very small spines, observable only under high magnifications in larger specimens and assumedly char-

acteristic of maturity; lateral (partial) sporangia always much smaller than main sporangium, varying from 6 to 14; spores found only in the partial sporangia, golden in color, spherical, averaging $3\ \mu$ in diameter.

This species is named for Dr. Julian Dana Corrington.

CONCHYLIASTRUM Zebrowski, gen. nov.

Hyphae ex apicibus sporangiorum secundariorum, longae, nova sporangia gignentis; sporangia secundaria fusiformia, elongata, radiata ex ventro globoso sporangii primarii cum ostiolo singulo cervice longa; sporae ovoideae, pachydermaticae.

Type: *Conchyliastrum Enderi* Zebrowski.

Primary sporangia subterminal, flask-shaped, with a long neck and round venter which proliferates to form long-fusiform, secondary sporangia with ovoid, thick-walled sporangiospores; hyphae arising from tips of secondary sporangia, spreading through the shell, and giving rise subterminally to another group of sporangia.

The genus name is derived from the Latin *concha* (shell) and *aster* (star).

Conchyliastrum Enderi Zebrowski, sp. nov. Pl. 27, figs. 7, 9.

Hyphae longae, 255–527 μ , ad 1 μ diametro; sporangia primaria 20 μ diametro, spherica, cervicibus cum tubularibus, 30 μ longitudine, et poris apicalibus circularibus, 5 μ diametro, proliferantia; sporangia lateralia, partialia, 2–14, plerumque 6–7, radiata, $34 \times 7\ \mu$, elongata, fusiformia vel ampulliformia; sporae 3 μ diametro, ovoideae, rubro-luteae, pachydermaticae.

Hyphae long, 255–527 μ , 1 μ in diameter; primary sporangia 20 μ in diameter, spherical, with tubular necks 30 μ long, and apical, circular pores 5 μ in diameter, proliferating; lateral or partial sporangia, 2–14, usually 6–7, radiating, $34 \times 7\ \mu$, elongate, fusiform or flask-shaped; spores 3 μ in diameter, ovoid, reddish-yellow, thick-walled.

Found in the calcareous parts of molluscan shells and in sponge spicules. This species is named for Dr. Howard E. Enders.

If the matrix is thick and permits of uncrowded development, the thallus develops a long-necked, flask-shaped, primary sac from the globular base of which radiate the lateral pouches (pl. 27, fig. 7). If, however, the matrix is too thin to permit of deep growth and normal expansion, the thallus will spread out in a single plane like the fingers of a hand (fig. 9). From the distal extremities of the lateral sacs emerge single hyphae which penetrate the matrix for long distances, eventually giving rise to new subterminal sacs (fig. 7). These daughter sacs elongate, become flask-shaped, develop lateral pouches and hyphae, and thus give rise to a new thallus.

***Conchyliastrum Merritti* Zebrowski, sp. nov. Pl. 27, fig. 11.**

Hyphae crassae, 5–3 μ diametro, ax apicibus sporangiorum partialium proliferantes, breves; sporangia primaria clavata, intercalaria, 75 \times 30 μ , cervicibus longis, poris apicalibus 5 μ diametro, irregulariter proliferantia; sporangia lateralia (partialia) 50 \times 10 μ , fusiformia, dein irregulariter subspherica; sporae brunneae, 1 μ diametro, sphaericae, catervatae in sporangiis primariis secundariisque.

Hyphae thick, 5 μ in diameter, tapering to 3 μ , proliferating from the tips of the partial sporangia, short; primary sporangia clavate, intercalary, 75 \times 30 μ , with long necks and apical pores 5 μ in diameter, irregularly proliferating to form secondary sporangia 50 \times 10 μ , fusiform at first, becoming irregularly subspherical; spores brown, 1 μ in diameter, spherical, collected into spore balls, seen both in the primary and in the secondary sporangia.

In its general structure and development this species resembles *C. Enderi*, but there is a lack of symmetry in the lateral pouches. They seem to arise as spindle-shaped outgrowths but soon become irregularly globular, no two being alike in shape and some as large as the primary sporangium. The hyphae are relatively short and stout, emerging as prolongations of the lateral sporangia so that it is difficult to tell where they begin. They also taper in their course, being about 5 μ thick at their origins and about 3 μ at their distal ends.

This species is named for Mr. Edgar B. Merritt.

ARBORELLA Zebrowski, gen. nov.

Hyphae dichotome ramosae, rhizoideis; sporangia terminalia, spherica, poris magnis; sporae non visae.

Type: *Arborella Kohli* Zebrowski.

Hyphae dichotomously branched, bearing minute rhizoids at the nodes; sporangia terminal, large, spherical, with a large pore; spores not seen.

The generic name was given because of a fancied resemblance of this form to a branch of a tree with fruit at its extremities.

Arborella Kohli Zebrowski, sp. nov.

Pl. 27, fig. 8.

Hyphae dichotome ramosae, 1.6 μ diametro, 20–70 μ inter ramis, rhizoideis ad 1 μ diametro; sporangia spherica, 10 μ diametro, poris magnis; sporae non visae.

Hyphae dichotomously branched, 1.6 μ in diameter, 20–170 μ between nodes, rhizoids about 1 μ in diameter; sporangia spherical, 10 μ in diameter, with large pores; spores not seen.

The main hyphae and branches are all about the same thickness and of somewhat irregular outline. The internodes vary in length and are thinner than the nodes. Each internode bears one or more rhizoidal hairs which penetrate the substrate and apparently emerge on the opposite side of the shell. The entire thallus lies buried within the living matrix of the shell. The sporangia are spherical with large pores of approximately the same diameter as that of the sac, which open on the same surface as the rhizoidal hairs.

This species is named for Dr. Edwin Jacob Kohl.

Arborella Calverti Zebrowski, sp. nov.

Hyphae dichotome ramosae, 1.4 μ diametro, ad 132 μ inter ramis, rhizoideis longis; sporangia elongata, irregulariter lobata, 12–33 μ diametro, sine poris; sporae non visae.

Hyphae dichotomously branched, 1.4 μ in diameter, about 132 μ between nodes, with long coiled rhizoids; sporangia elongate, irregularly lobed, 12–33 μ in diameter, apparently rupturing irregularly, without a well-defined pore; spores not seen.

The main hyphae bearing the sporangia lie beneath one sur-

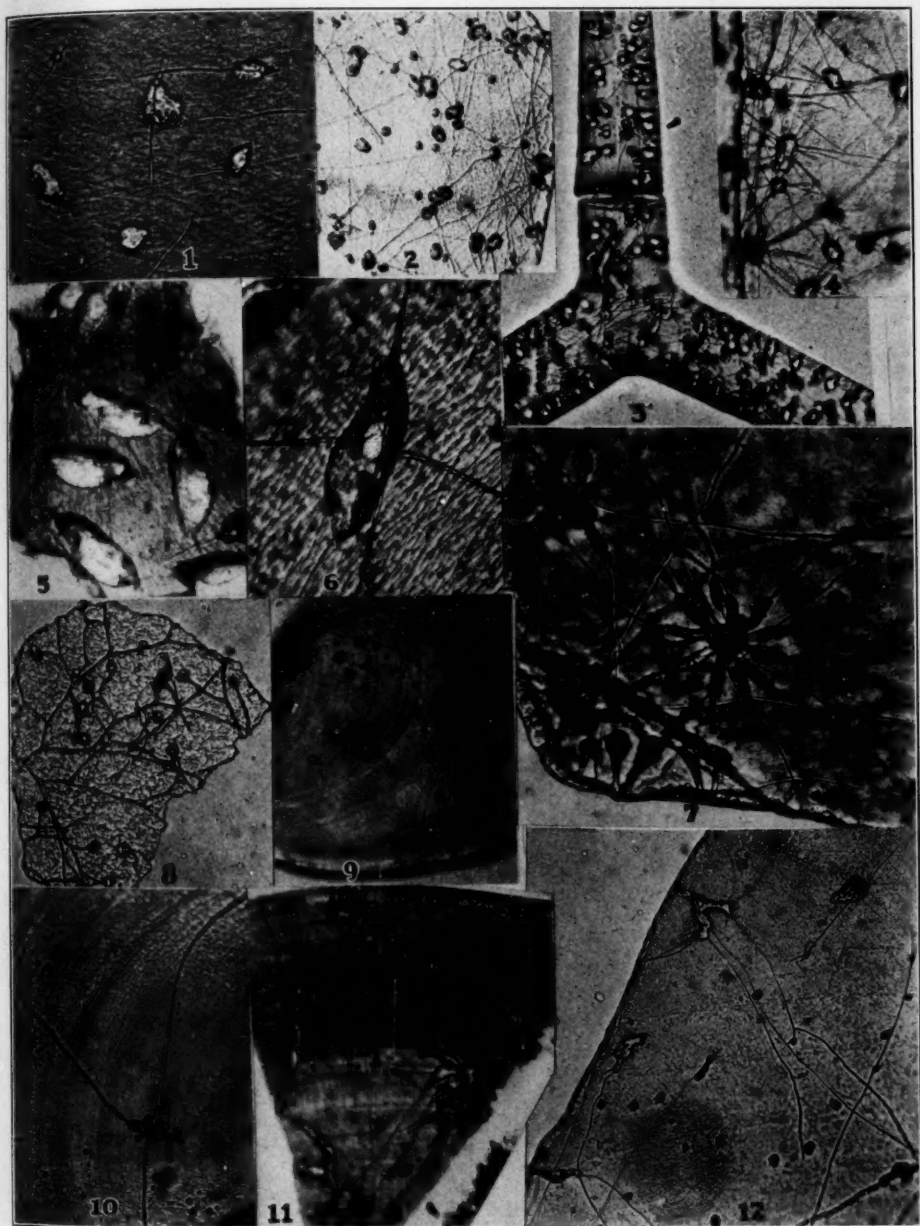
face of the shell. The rhizoids arise from both nodes and internode and penetrate within the matrix, producing an abundant, tangled network of threads. Frequently a node gives rise to both a sporangiferous branch and a rhizoid.

The species is named for Dr. Phillip Powell Calvert.

EXPLANATION OF PLATE

PLATE 27

- Figs. 1 and 3. *Dodgella priscus*.
Fig. 2. *Dodgella inconstans*.
Fig. 4. *Dodgella radicans*.
Figs. 5-6. *Paramoeciella Gamblei*.
Figs. 7 and 9. *Conchyliastrum Enderi*.
Fig. 8. *Arborella Kohli*.
Fig. 10. *Arthurella Corringtoni*.
Fig. 11. *Conchyliastrum Merritti*.
Fig. 12. *Coulterella Petersoni*.



ZEBROWSKI—NEW GENERA OF CLADOCHYTRIACEAE



HYDNANGIUM AND RELATED GENERA¹

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In continuation of our studies on the Hymenogasteraceae (*sensu latiore*) we present here and in the following paper² the genera belonging to the Hydnangiaceae as defined by Dodge,³ except *Lycogalopsis* of which we have seen too little authentic material to present at this time. Malençon⁴ proposed the family name Asterogasteraceae for essentially this same group, although he notes that *Sclerogaster* is very aberrant, and apparently he overlooked *Maccagnia* and *Lycogalopsis*. He would also include the gymnocarpous Russulaceae in the same series Astérosporés. *Hydnangium* has had a relatively simple tradition since its first description, although from time to time discordant elements have been referred to it. The small generic segregates are easily recognized. Since all the genera have not been included here, due to lack of authentic material, we prefer to postpone a discussion of generic relationships until more data are available. The key on the next page will serve to identify material in this and the following paper:

¹Published as Technical Paper No. 254, with the approval of the Director of the Oregon Agricultural Experiment Station. Contribution from the Department of Botany in cooperation with the Henry Shaw School of Botany of Washington University.

²Zeller, S. M., and C. W. Dodge. *Elasmomyces*, *Arcangeliella*, and *Macowanites*. *Ann. Mo. Bot. Gard.* 23: 599-638. 1936.

³Gäumann, E. A., and C. W. Dodge. *Comparative morphology of fungi*. 701 pp. McGraw Hill Book Co., New York, 1928. (See pp. 485-488.)

⁴Malençon, G. *La série des Astérosporés*. *Trav. Cryptog. dédiés à Louis Mangin*, 377-396. pl. 29. 1931. (See p. 392.)

Issued January 8, 1937.

1. Fructification angiocarpous, but peridium is sometimes absent from a narrow space about the stipe in *Arcangeliiella*..... 2
1. Fructification hemiangiocarpous, the lower portion of the gleba completely exposed at maturity.....*Macowanites* (p. 636)
 2. Sterile base present and highly developed at maturity, lignicolous; tropical.....*Lycogalopsis*
 2. Sterile base sometimes present when young but not highly developed and persistent; terrestrial (except *Sclerogaster luteocarnus*)..... 3
3. Spores very thick-walled, appearing smooth under lower magnifications, but minutely echinulate to verrucose under higher powers..... 4
3. Spores thinner-walled, alveolate to echinulate or rugose..... 5
 4. Latex absent, columella usually absent.....*Sclerogaster* (p. 566)
 4. Latex present, columella present.....*Maccagnia* (p. 573)
5. Columella absent, spores echinulate to echinate..... 6
5. Columella present, spores alveolate to echinate..... 7
 6. Spores spherical or nearly so, echinulate to echinate....*Hydnangium* (p. 574)
 6. Spores long-ellipsoid, echinate with a broad collar at the base.....*Stephanospora* (p. 597)
7. Latex absent, spores echinulate.....*Elasmomyces* (p. 600)
7. Latex present, spores alveolate, rugose, or echinulate....*Arcangeliiella* (p. 602)

We have used the same color standards, and cited the specimens with the same abbreviations as in our previous work.⁵ Besides those whose aid was gratefully acknowledged in previous papers, we are indebted to Mrs. Olive Rodway for the loan of material from the Rodway Herbarium at the Tasmanian Museum. For financial assistance we are grateful to the American Association for the Advancement of Science (grant in 1923 to the junior author), and to the John Simon Guggenheim Memorial Foundation, which appointed the senior author a fellow to Europe in the autumn of 1930, and to the Science Research Fund of Washington University (grant to the senior author in 1933).

SCLEROGASTER

Sclerogaster Hesse, Hypog. Deutschl. 1: 84-86. 1891; Sacc. Syll. Fung. 11: 170. 1895; Bataille, Bull. Soc. Myc. France 39: 180. 1923; Coker & Couch, Gasteromycetes Eastern U. S. & Canada, 25-26. 1928; E. Fischer, in Engler & Prantl, Die Nat. Pflanzenfam. ed. 2, 7a: 18. 1933.

The type species of the genus is *Sclerogaster lanatus* Hesse.

⁵ Dodge, C. W., and S. M. Zeller. Hymenogaster and related genera. Ann. Mo. Bot. Gard. 21: 625-708. pl. 18. 1934. (See pp. 625-627.)

Fructifications small, white, embedded in a thick, flocculent mycelium, attached by rooting fibrils; peridium usually soft; gleba usually pale yellowish, gelified, drying very hard, cavities small, usually filled with spores similar to *Leucogaster* in shape; basidia small, cylindric to clavate, sterigmata short; spores small, thick-walled, spherical, appearing smooth under lower magnifications but mostly minutely echinate to verrucose under higher powers.

This well-marked genus seems to form a transition between *Leucogaster* and *Hydnangium* or *Arcangeliiella*. The spores are much smaller than the average in the above genera and have a relatively thicker wall. In some species there are faint suggestions of a columella but no lactiferous ducts have been seen. In general appearance the fructifications resemble *Leucogaster* but have very minute cavities. They have usually been included in *Hydnangium* (*Octaviania* Auct. non Vitt.) on account of the echinate spores.

The species seem confined to Europe, with one species in southeastern United States, one in tropical America, and one in Oregon and California. Each species seems quite limited in its distribution.

KEY TO SPECIES OF SCLEROGASTER

1. Peridium separable..... 2
1. Peridium not separable..... 4
 2. Peridium duplex, layers separating readily at maturity; spores 4-6 μ in diameter.....1. *S. lanatus* (p. 568)
 2. Peridium of thin-walled pseudoparenchyma.....2. *S. pacificus* (p. 568)
 2. Peridium of loosely tangled hyphae in a gel..... 3
3. Peridium 180-250 μ thick.....3. *S. hysteroangioides* (p. 569)
3. Peridium about 300 μ thick.....4. *S. Broomeianus* (p. 569)
 4. Peridium not more than 100 μ thick..... 5
 4. Peridium 100-200 μ thick..... 6
 4. Peridium more than 350 μ thick.....5. *S. luteocarneus* (p. 570)
5. Spores 6-8 μ in diameter; peridium of loosely tangled hyphae.....
 -6. *S. candidus* (p. 570)
5. Spores 4-5 μ in diameter; peridium of loose periclinal hyphae.....
 -7. *S. siculus* (p. 571)
6. Spores 7-9 μ in diameter, verrucose; peridium 140 μ thick, of periclinal hyphae.....8. *S. minor* (p. 572)
6. Spores 6-7 μ in diameter, smooth or nearly so; peridium 180 μ thick, of periclinal hyphae.....9. *S. liospermus* (p. 572)

6. Spores 4-6 μ in diameter, finely echinate; peridium 120-140 μ thick, of loosely tangled hyphae.....10. *S. compactus* (p. 573)

1. *SCLEROGASTER LANATUS* Hesse, Hypog. Deutschl. 1: 85-86. 1891, excl. syn.

Illustrations: Hesse, Hypog. Deutschl. 1: *pl. 5, f. 11*.

Type: in Herb. Bot. Inst. Univ. Marburg, a fragment in Dodge Herb.

Fructifications up to 1 cm. in diameter, spherical, snow-white, woolly; peridium duplex, inner layer of the same texture as the trama, about 280 μ thick, the outer layer 40 μ thick, of more loosely woven hyphae with abundant crystal deposits tearing away in places; gleba snow-white at first, becoming apricot-yellow, hard; cavities small, not filled with spores; septa about 35 μ thick, of slender periclinal hyphae embedded in a gel; basidia cylindric, $14 \times 4 \mu$, 4-8-spored; sterigmata short; spores spherical, 4-6 μ in diameter, thick-walled, smooth or nearly so.

Under duff in coniferous woods. England and Germany. May to October.

The type seems still rather immature; at least cavities are still being formed at the inner portion of the "peridium."

GERMANY: Hessen-Nassau, Cassel, *R. Hesse*, 1887, type (Hesse and Dodge).

ENGLAND: Kent, Orford, *C. E. Broome* (Broome Herb. at Kew).

2. *SCLEROGASTER PACIFICUS* Zeller & Dodge, Ann. Mo. Bot. Gard. 22: 370. 1935.

Type: in Zeller and Dodge Herbaria.

Fructifications subspherical, drying 0.8-1.0 cm. in diameter, dirty white; sterile base present; columella not seen; peridium evanescent, about 100 μ thick, pseudoparenchymatous, cells up to $200 \times 30 \mu$, very thin-walled; gleba firm, finally friable, ochraceous-buff; cavities polyhedral, filled with spores; septa of loosely woven, slender hyphae in a gel, thin, 20-30 μ thick; basidia clavate, soon collapsing and evanescent; spores spherical, with very large verrucae, 9-10 per great circle, 7-8 μ in diameter.

This species seems aberrant in some respects, with its sterile base and gleba finally becoming friable, but it seems more closely related here than elsewhere.

OREGON: Coos County, Bandon, *S. M. Zeller 7425*, type (Zeller and Dodge).

3. *SCLEROGASTER HYSTERANGIOIDES* (Tulasne) Zeller & Dodge, *Ann. Mo. Bot. Gard.* **22**: 370. 1935.

Hydnangium hysterangioides Tulasne, *Fung. Hypog.* 76. 1851; DeToni in *Sacc. Syll. Fung.* 7: 177. 1888.

Octaviania hysterangioides Lloyd, *Myc. Notes* 67. 1141. 1922.

Illustrations: Tulasne, *Fung. Hypog. pl. 21, f. 5*.

Type: in Broome Herb. at British Museum, a slice from type in Lloyd Museum, material from the same locality and collector at the same date, agreeing wholly with the description but determined as *Octaviania compacta* Tul., in the J. W. Bailey Collection at Brown University.

Fructifications small, 0.6×0.4 mm. when dry, dirty white, surface flocculent, drying slightly rugose; peridium 180–250 μ thick, composed of loosely tangled hyphae embedded in a gel; gleba maize-yellow to buff-yellow or light brownish-olive in young material; cavities minute, $100 \times 300 \mu$, filled with spores in the older specimens; septa hyaline, easily scissile, 7–10 μ thick between hymenia, composed of slender, gelified hyphae; basidia clavate, $12 \times 6 \mu$; sterigmata short; spores small, spherical, slightly echinulate, appearing smooth under the lower powers of the microscope, hyaline to dilute cream-color in mass, 4.5–6.5 μ in diameter.

ITALY: Rome, *C. E. Broome* (under *Octaviania compacta* Tul., Brown Univ. 56, and Farlow); Rome, Panfilo Gardens, *C. E. Broome*, 1846, type (Brit. Mus., Kew, and slide from type in Lloyd Mus.).

4. *SCLEROGASTER BROOMEIANUS* Zeller & Dodge, *Ann. Mo. Bot. Gard.* **22**: 370. 1935.

Octaviania compacta Masee, *Ann. Bot.* **4**: 32–33. 1889 [often cited as *Monogr. Brit. Gast.*].

Illustrations: Masee, *Ann. Bot.* **4**: *pl. 1, f. 12*.

Type: in Broome Herb. at British Museum and Berkeley Herb. at Kew.

Fructifications 0.5×0.3 cm., depressed-globose, white; peridium separable, 280 μ or more thick, composed of a prosenchyma of hyphae 3–4 μ in diameter; gleba isabella-color or

dark olive-buff, with minute cavities filled with spores; septa scissile, 20–30 μ between hymenia, of slender, loosely woven periclinal hyphae embedded in a gel; basidia clavate, 7–8 \times 3–4 μ , with short sterigmata; spores spherical, thick-walled, minutely and sparsely echinate, 5–7 μ in diameter.

Among grass roots. Southern England. October and November.

EXSICCATI: Rabenhorst, Fung. Eur. 2502.

ENGLAND: Gloucestershire, Leigh Wood, C. E. Broome, type (Brit. Mus. and Kew); Kent, Shoreham, C. E. Broome, distributed in Rabenhorst, Fung. Eur. 2502.

5. *SLEROGASTER LUTEOCARNEUS* (Bresadola) Zeller & Dodge, Ann. Mo. Bot. Gard. 22: 370. 1935.

Octaviania luteocarpa Bresadola, Ann. Myc. 18: 54. 1920; Trotter in Sacc. Syll. Fung. 23: 601. 1925.

Arcangeliella luteocarpa Lloyd, Myc. Notes 67: 1142. 1922; Rick, Egatea 19: 111. 1934.

Type: in Lloyd Museum.

Fructifications subspherical or obovate, 0.7–1.0 cm. in diameter, smooth, yellowish flesh-color becoming brownish; sterile base conical, about 3 mm. tall, forming the suggestion of a columella; peridium not separable, loose, stupose, 360–380 μ thick, with outer mycelial patches composed of periclinal hyphae next the gleba and on the outside, with tangled thick-walled hyphae between; gleba yellowish flesh-color; cavities polyhedral; septa white, composed of hyphae 3–4.5 μ in diameter; basidia clavate, 22–24 \times 6–7 μ ; spores spherical, tuberculate-echinulate, 6–7.5 μ in diameter, often with the remains of the sterigma 2–3 μ long.

On wood. Tropical America.

GUADELOUPE: Bois de Bains Jaunes, Duss, 1895 (Berlin and Farlow).

BRAZIL: Rio Grande do Sul, Poco das Antas, J. Rick 51, type (Lloyd Mus. 06025, and Dodge).

6. *SLEROGASTER CANDIDUS* (Tulasne) Zeller & Dodge, Ann. Mo. Bot. Gard. 22: 370. 1935.

Hydnangium candidum Tulasne, Ann. Sci. Nat. Bot. II. 19: 376. 1843; Fung. Hypog. 75. 1851; DeToni in Sacc. Syll. Fung. 7: 176. 1888; Lloyd, Myc. Notes 67: 1142. 1922.

Illustrations: Payer, Bot. Crypt. 114, f. 527; Quélet, Mém. Soc. d'Émulation de Montbéliard 4: pl. 4, f. 2 [often cited as Champ. du Jura et des Vosges 2: pl. 4, f. 2]; Roumeguère, Cryptog. Illustr. f. 376; Tulasne, Ann. Sci. Nat. Bot. II. 19: pl. 17, f. 20; Fung. Hypog. pl. 21, f. 2.

Type: in Tulasne Herb. at Paris and in Broome Herb. at British Museum.

Fructifications the size of a filbert, globose, regular, somewhat soft, with a minute absorbing base; fibrils absent; peridium membranaceous, smooth, white, at length becoming light yellow, rimose, not separable, 80–90 μ thick, of very slender, densely tangled hyphae; gleba light ochraceous; cavities small, usually empty; septa thin, 12–15 μ thick, homogeneous, of gelified hyphae, not scissile; basidia 2–3-spored, rarely 4-spored, cylindrical; cystidia narrower, elongate-conical; spores hyaline, more deeply colored with age, becoming fuscous, 6.5–8.5 μ in diameter, spines short, sometimes appendiculate.

Almost epigeous. Solitary in shady stands of *Carpinus*. Italy and France.

ITALY: Lucca, C. E. Broome (Brit. Mus.).

FRANCE: Vienne, Couhe-Verac, Tulasne, Oct. 1841, type (Paris and Brit. Mus.); Doubs, Hérimoncourt, L. Quélet (Upsala); Jura, L. Quélet (Upsala).

7. *SCLEROGASTER SICULUS* Zeller & Dodge, Ann. Mo. Bot. Gard. 22: 371. 1935.

Sclerogaster lanatus Mattiolo, Malpighia 14: 85–86. 1900.—non Hesse, Hypog. Deutschl. 1: 84. 1891.

Type: in Mattiolo and Dodge Herb. and Lloyd Museum.

Fructifications 0.6 \times 0.4 cm., depressed-globose, white, floccose; peridium duplex, the outer layer variable in thickness, composed of slender, thick-walled hyphae entangling soil particles, inner layer about 90 μ thick, composed of densely woven, periclinal hyphae; gleba ochraceous-tawny, hard; cavities filled with spores; septa about 30 μ thick between hymenia; basidia evanescent; spores brown, thick-walled, sparsely and minutely echinate, 4.1–5.6 μ .

Sicily, known only from the type locality.

SICILY: Fanfani a Cefalu, O. Mattiolo, 4 Apr. 1900, type (Lloyd Mus. and Dodge).

8. *SCLEROGASTER MINOR* Coker & Couch, Gast. Eastern U. S. & Canada, 25-26. 1928.

Illustrations: Coker & Couch, Gast. Eastern U. S. & Canada, pl. 17, 18, 106.

Type: in Herb. Univ. North Carolina.

Fructifications depressed-globose, $0.3-1.0 \times 0.3-0.7$ cm., more or less covered with a cottony mycelium, white; peridium $300-450 \mu$ thick, drying 140μ , with a thin, cottony outer layer and a thick, pseudoparenchymatous inner layer, easily separable; gleba white, becoming deep ochraceous-yellow, with suggestions of a columella; cavities minute, filled with spores; septa $60-185 \mu$ thick, composed of septate hyphae $3-5 \mu$ in diameter; basidia long, cylindrical, $28-40 \times 4-7.4 \mu$, 1-5-spored; spores $7.4-9.5 \mu$ in diameter, spherical, smooth at first, becoming warted.

Under *Juniperus*. North Carolina. August.

NORTH CAROLINA: Chapel Hill, J. N. Couch 7474, type (Univ. N. Car. Herb.).

9. *SCLEROGASTER LIOSPERMUS* (Tulasne) Soehner, Krypt. Forsch. 1: 393. 1924.

Hydnangium liospermum Tulasne, Fung. Hypog. 76. 1851; DeToni in Sacc. Syll. Fung. 7: 176. 1888; Hesse, Hypog. Deutschl. 1: 84. 1891; Zeller & Dodge, Ann. Mo. Bot. Gard. 11: 407-408. 1924.

Octaviania liosperma Lloyd, Myc. Notes 67: 1141, 1923.

Illustrations: Tulasne, Fung. Hypog. pl. 21, f. 1.

Type: in Tulasne Herb. at Paris.

Fructification size of a pea, firm, spherical, white, with a slight sterile base, here and there enveloped in a white-floccose mycelium, separating in places; peridium about 180μ thick, not separable, homogeneous, of periclinal hyphae embedded in a gel, continuous with the septa; gleba firm, light ochraceous to apricot-color; cavities unequal in size, narrow, oblong, radiating from the center to the periphery; septa cartilaginous, gray, variable in thickness, those arising from the base much thicker than the others; spores borne terminally, mostly on short sterigmata, spherical, $6-7 \mu$ in diameter, smooth or nearly so, rather thick-walled.

Under fallen leaves in oak woods. France. Autumn.

FRANCE: Loiret, Gien, Parc de Beauvoir, *Tulasne*, type (Paris).

10. *SCLEROGASTER COMPACTUS* (Tulasne) Saccardo, Syll. Fung. 11: 170. 1895.

Octaviania compacta Tulasne, Giorn. Bot. Ital. 1²: 55. 1844; Fung. Hypog. 79. 1851; DeToni in Sacc. Syll. Fung. 7: 160. 1888; Lloyd, Myc. Notes 67: 1142. 1922, in part.

Hydnangium compactum Quélet, Ench. Fung. 247. 1886.—not Harkness, Proc. Cal. Acad. Sci. Bot. III. 1: 250. 1899.

Octavianina compacta O. Kuntze, Rev. Gen. Pl. 3²: 501. 1898.

Illustrations: Tulasne, Fung. Hypog. *pl.* 11, *f.* 3.

Type: in Berkeley Herb. at Kew, Broome Herb. at British Museum, and Tulasne Herb. at Paris.

Fructifications small, spherical, drying about 6 mm. in diameter, covered by a loose, flocculent mycelium; columella penetrating to the center of the fructification or a little beyond; peridium 120–140 μ thick, not separable, of large, loosely tangled, thin-walled hyphae; gleba cinnamon-buff, texture very hard as in *Leucogaster*; cavities filled with spores; septa thin, about 15 μ thick between hymenia, composed of more or less periclinal, thick-walled hyphae embedded in a gel; basidia evanescent; spores spherical, sparsely and minutely warted, thick-walled, 4–6 μ in diameter.

FRANCE: Var, Hyères, *Tulasne*, 1844, 1845, type (Kew, Brit. Mus., and Paris); Provence, *E. Boudier*, 1900 (Paris).

MACCAGNIA

Maccagnia Mattiolo, R. Accad. Naz. dei Lincei. V. 13¹²: 13–17. 1922; *E. Fischer* in Engler & Prantl, Die Nat. Pflanzenfam. ed. 2, 7a: 23. 1933.

The type species of the genus is *Maccagnia carnica* Mattiolo.

Fructifications small, spherical, drying hard and horny; columella highly developed; lactiferous ducts abundant; cavities filled with small hyaline, thick-walled spores on zig-zag hyphae, as in *Leucogaster* and *Leucophlebs*, which soon form a gel in

which the basidia and spores are later borne; spores spherical with a thick epispore, rather small, echinate.

This genus seems intermediate between *Sclerogaster*, *Leucogaster*, and *Arcangeliella*, having the spores and texture of a *Sclerogaster*, the general ontogeny of a *Leucogaster*, and the columella and lactiferous ducts of an *Arcangeliella*. It will be remembered that *Sclerogaster compactus* and *S. luteocarneus* have a more or less well-developed columella but in all other characters seem closer to *Sclerogaster* than to *Maccagnia*. So far this genus is known from a single collection from Italy.

MACCAGNIA CARNICA Mattiolo, R. Accad. Naz. dei Lincei. V. 13¹²: 13-17. 1922.

Illustrations: R. Accad. Naz. dei Lincei. V. 13¹²: pl. 1.

Type: Probably in Mattiolo Herb., a portion in Patouillard Herb. at Farlow Herb.

Fructifications small, 0.8-1.0 cm. in diameter, spherical, sometimes attenuate at the base, becoming horn-like when dry, isabelline-yellow to isabelline-umber; peridium 120-150 μ (mean 125 μ) thick, composed of very slender periclinal hyphae with very abundant, varicose, tortuous, moniliform, lactiferous ducts filled with a transparent yellow substance; columella branched, forming the veins; gleba chestnut-color; cavities radially arranged, somewhat circular, at first filled with small, hyaline, thick-walled spores 3-4 μ in diameter borne on zig-zag hyphae; septa thin, of highly gelified hyphae with lactiferous ducts; basidia clavate on a long pedicel, gelifying early, 4-, rarely 2-spored, sterigmata filiform; spores spherical, slightly appendiculate, epispore relatively thick, yellow-greenish, 4-5 μ , occasionally 6 μ , in diameter.

ITALY: Udine, Gemona, *Maccagni* (Mattiolo Herb. and Farlow).

HYDNANGIUM

Hydnangium Wallroth in Dietrich, Fl. Reg. Boruss. [Fl. Königr. Preuss.] 7: no. 465. 1839; Corda, Anleit. z. Stud. Myc. 114, lxxxiii. 1842; Icon. Fung. 5: 28. 1842; Tulasne, Ann. Sci. Nat. Bot. II. 19: 376. 1843; Fung. Hypog. 74. 1851; Rabenhorst, Deutschl. Krypt.-Fl. 1: 249. 1844; Fries, Summa Veg.

Scand. 436. 1849; Berkeley, Outlines Brit. Fungol. 293. 1860; Winter in Rabenhorst, Krypt.-Fl. Deutschl. ed. 2. 1: 877. 1883; Quélet, Ench. Fung. 247-248. 1886; DeToni in Sacc. Syll. Fung. 7: 175-177. 1888; Hesse, Hypog. Deutschl. 1: 81-84. 1891; E. Fischer in Engler & Prantl, Die Nat. Pflanzenfam. I. 1^{**}: 310. 1899; and ed. 2, 7a: 30-31. 1933; Hollós, Magyar. Földalatti Gombai, 96-97, 207-208. 1911.

Martellia Mattiolo, Malpighia 14: 78-82. 1900; Saccardo & Sydow in Sacc. Syll. Fung. 16: 252. 1902.

Octaviania Auct. (pro parte) especially Lloyd, Myc. Notes 7: 1138-1142. 1922 (for discussion of nomenclature see Ann. Mo. Bot. Gard. 23: 603-604. 1936).

The type species of the genus is *Hydnangium carneum* Wallroth. The type species of *Martellia* is *M. mistiformis* Mattiolo. The type species of *Octaviania*, as used by authors subsequent to Tulasne including Lloyd, is *O. asterosperma* Vitt.

Fructifications spherical to slightly irregular, without sterile base or columella; peridium filamentous or prosenchymatous, rarely pseudoparenchymatous, more or less uniform in texture, without lactiferous ducts; gleba often fragile as in *Hymenogaster*, usually light-colored; basidia mostly 4- or 2-spored, usually projecting beyond the general level of the hymenium at maturity; spores spherical or nearly so, echinate, often with long slender spines not alveolate, or with ridges as is frequently the case in *Arcangeliella*.

Various characters have been used to separate this genus from the genus *Arcangeliella*. The early authors emphasized the presence or absence of sterile base, referring here species without one, and to *Octaviania* those with a well-developed one. While this character may be of some theoretical importance from the standpoint of developmental morphology it is very difficult to apply, as in very few species does the sterile base persist to full maturity, with a result that immature specimens were apt to be referred to *Octaviania* and very mature ones to *Hydnangium*. In the present treatment this practice has been followed, but it has not been used as a key character, as other characters are easier to apply. In the latter part of the last century, ease of dehiscence of the peridium was used.

Again this character is difficult to apply, as so many variations occur and too often the peridium is partly lacking rather as an accident to the individual specimens than because of any morphological character. In general, the species with a separable peridium are referable to *Arcangeliella* and those with a more persistent peridium remain in *Hydnangium*. An important exception is *H. mistiforme* Matt. which was segregated by Mattiolo chiefly on this character as *Martellia*. The spores are also brown rather than hyaline. Neither character seems sufficiently important to us to warrant generic segregation in the light of our present knowledge of the group. Lloyd, Myc. Notes 7: 1139-1142. 1922, redefined *Arcangeliella* as having a gleba "hard cartilaginous (horny when dry), hard to cut" including the type species *A. Borziana* Cav. and *A. luteo-carnea* (Bres.) Lloyd, the latter species here treated as *Sclerogaster* although slightly aberrant in that genus. All the other echinulate and alveolate species were referred to *Octaviania*. Hardness of the gleba seems to us an accidental character, dependent partly on the thickness of septa, their state of gelification, and method or care in drying.

KEY TO SPECIES OF HYDNANGIUM

- | | |
|--------------------------------------------------------------------------------------|-------------------------------------------------------|
| 1. Peridium duplex..... | 2 |
| 1. Peridium simplex, without pseudoparenchyma..... | 5 |
| 2. Pseudoparenchyma present in one layer of peridium..... | 3 |
| 2. Pseudoparenchyma absent; spores dark brown..... | 4 |
| 3. Spores dark brown..... | 1. <i>H. citrinum</i> (p. 577) |
| 3. Spores hyaline..... | 2. <i>H. monticola</i> (p. 578) |
| 4. Spores 6-8 μ in diameter; peridium 800 μ thick..... | 3. <i>H. Eisenii</i> (p. 578) |
| 4. Spores 10-13 μ in diameter; peridium thinner..... | 4. <i>H. laeve</i> (p. 579) |
| 5. Spores hyaline or nearly so..... | 6 |
| 5. Spores brown..... | 12 |
| 6. Spores 5-6 μ in diameter..... | 5. <i>H. compactum</i> (p. 580) |
| 6. Spores 7.4-9 μ in diameter..... | 6. <i>H. Parksii</i> (p. 580) |
| 6. Spores mostly over 20 μ in diameter, echinulate, spines 3-3.5 μ long..... | 7. <i>H. Gülkeyae</i> (p. 581) |
| 6. Spores 10-20 μ in diameter..... | 7 |
| 7. Peridium white, 400 μ thick..... | 8. <i>H. album</i> (p. 581) |
| 7. Peridium pinkish or reddish..... | 8 |
| 7. Peridium yellow or brownish..... | 9 |
| 8. Peridium 30-40 μ thick..... | 9. <i>H. pila</i> (p. 582) |
| 8. Peridium 110-120 μ thick..... | 10a. <i>H. carneum</i> var. <i>purpureum</i> (p. 584) |
| 8. Peridium 150-270 μ thick..... | 10. <i>H. carneum</i> (p. 582) |

9. Sterile base prominent, hemispheric, stipe short, slender; peridium 200 μ thick.....11. *H. pusillum* (p. 585)
9. Sterile base not prominent..... 10
10. Peridium thick, 1200-1300 μ12. *H. luteolum* (p. 585)
10. Peridium 150-280 μ thick..... 11
10. Peridium 110-120 μ thick.....10a. *H. carneum* var. *purpureum* (p. 584)
10. Peridium 60-80 μ thick.....13. *H. Archeri* (p. 586)
10. Peridium thin, septa thick.....14. *H. aurantiacum* (p. 586)
11. Spores 15-16 μ in diameter.....15. *H. monosporum* (p. 587)
11. Spores 8.5-12 \times 11-14 μ16. *H. aurantium* (p. 588)
12. Spores 6-10 μ in diameter..... 13
12. Spores 10-20 μ in diameter..... 14
13. Peridium separable, white-olivaceous.....17. *H. mistiforme* (p. 588)
13. Peridium not separable, capucine-yellow or pink.....18. *H. Thaxteri* (p. 589)
14. Peridium white, changing to deep vinaceous, drying vinaceous, 500-600 μ thick.....19. *H. purpureum* (p. 589)
14. Peridium white, changing to dark brown on exposure, about 300 μ thick.....20. *H. Hessei* (p. 590)
14. Peridium white, unchanging, 600-700 μ thick.....
-21. *H. lanigerum* (p. 591)
14. Peridium pale flesh-color, 140 μ thick.....22. *H. javanicum* (p. 592)
14. Peridium brownish..... 15
14. Peridium black, 260-270 μ thick.....23. *H. nigricans* (p. 592)
15. Peridium thick, 900-1000 μ24. *H. tuberculatum* (p. 593)
15. Peridium 400-500 μ thick; Australia.....25. *H. densum* (p. 593)
15. Peridium 300-400 μ thick, auburn or chestnut.....26. *H. luteum* (p. 594)
15. Peridium 50-60 μ thick, dark brown to black.....27. *H. Soehneri* (p. 595)
15. Peridium 40-50 μ thick, waxy yellow drying tawny.....28. *H. cereum* (p. 595)

1. *HYDNANGIUM CITRINUM* (Harkness) Zeller & Dodge, Ann. Mo. Bot. Gard. 22: 371. 1935.

Octaviania citrina Harkness, Proc. Cal. Acad. Sci. Bot. III. 1: 252. 1899; Saccardo & Sydow in Sacc. Syll. Fung. 16: 248-249. 1902.

Type: cotype in Dudley Herb. at Leland Stanford Jr. Univ.

Fructifications depressed-globose to irregular, 1.3 \times 2 cm., white becoming ochraceous-tawny in alcohol, dirt clinging to the peridium in spots; peridium duplex, 200 μ thick, the outer portion of strands of parallel hyphae which grow outward and entangle dirt, with pseudoparenchyma of large cells within; gleba orange, becoming ochraceous-tawny in alcohol; cavities empty; septa 70-80 μ thick, composed of pseudoparenchyma with cells 10-11 μ in diameter; basidia clavate, 4-spored, 20 \times 11 μ ; sterigmata 6-7 μ long with slightly swollen bases; spores

spherical, echinulate, pedicellate, yellow-brown, 10–12 μ in diameter.

Under *Arctostaphylos glaucus*. California. April.

The cotypes in the Dudley Herbarium have no data associated with them other than the numbers on the bottles and the names which Harkness gave them. Harkness mentions three localities in his original description and there are three bottles labeled *Octaviania citrina* in the Dudley Herb. Two of them belong clearly to this species, while the third, of very different structure although of much the same color, seems to be discolored specimens of *H. carneum*. Harkness cites as his localities: Oat Hill Quicksilver Mine, Solano County; Camp Taylor, Marin County; and Calistoga, Napa County.

CALIFORNIA: *H. W. Harkness 155b, 157, cotype* (Stanford).

2. *HYDNANGIUM MONTICOLA* (Harkness) Zeller & Dodge, Ann. Mo. Bot. Gard. 22: 372. 1935.

Octaviania monticola Harkness, Proc. Cal. Acad. Sci. Bot. III. 1: 254. 1899. Saccardo & Sydow in Sacc. Syll. Fung. 16: 248. 1902.

Illustrations: Harkness, Proc. Cal. Acad. Sci. Bot. III. 1: pl. 42, f. 3.

Type: cotype in Dudley Herb. at Leland Stanford Jr. Univ.

Fructifications irregular, 2 \times 3 \times 3 cm., flexible, buff, becoming Verona brown in alcohol; sterile base prominent, no columella; peridium duplex, 300 μ thick, the outer layer up to 100 μ thick, composed of thin-walled, slender, hyaline hyphae, the inner layer pseudoparenchymatous; gleba a little lighter than the peridium, spongy; cavities empty; septa hyaline, 80–120 μ thick, of rather indefinite structure resembling the outer peridium; basidia clavate, 35 \times 6–7 μ , 4-spored; sterigmata short; spores 10–12 μ in diameter, minutely verrucose.

Mountain regions in sandy soil. California. April.

CALIFORNIA: Placer County, Auburn, *H. W. Harkness 13*, cotype (Stanford); Santa Clara County, Alma, *H. E. Parks 404* (Univ. Cal. and Zeller).

3. *HYDNANGIUM EISENII* (Harkness) Zeller & Dodge, Ann. Mo. Bot. Gard. 22: 371. 1935.

Melanogaster Eisenii Harkness, Proc. Cal. Acad. Sci. Bot. III. 1: 259. 1899.

Type: cotype in Dudley Herb. at Leland Stanford Jr. Univ.

Fructifications 1.5 cm. in diameter, brown becoming russet to clay-color in alcohol; peridium about 500–600 μ thick, composed of very slender, thin-walled, compactly woven hyphae, with clamp connections, frequently ending in pyriform bodies, but composing a single, hyaline, homogeneous layer, with a dark brown surface of the same texture, about 7 μ thick; gleba dark brown; cavities densely crowded with spores; septa brownish, soon disappearing, composed of small, gelified, interwoven hyphae; basidia inconspicuous, $25 \times 7 \mu$; sterigmata long; spores brown, globose, echinate, 6–8 μ in diameter.

Lower California. January.

MEXICO: Baja California, Cabo S. Lucas, *G. Eisen*, cotype (Harkness 116, Stanford, and histological slide of a fragment in Zeller).

4. *HYDNANGIUM LAEVE* (Hesse) Zeller & Dodge, Ann. Mo. Bot. Gard. 22: 372. 1935.

Octaviania laevis Hesse, Hypog. Deutschl. 1: 80–81. 1891.

Octavianina laevis O. Kuntze, Rev. Gen. Pl. 3²: 501. 1898.

Octaviania levis Saccardo, Syll. Fung. 11: 169. 1895.

Arcangeliiella laevis (Hesse) Dodge, Ann. Mo. Bot. Gard. 22: 368. 1935.

Illustrations: Hesse, Hypog. Deutschl. 1: pl. 7, f. 15–17.

Type: location unknown to us but authentic material in Herb. Bot. Inst. Univ. Marburg.

Fructifications spherical, 1.5 cm. in diameter, smooth, white then russet to almost black in alcohol; peridium thin, duplex, outer layer sloughing off leaving patches composed of septate hyphae, inner layer 30–40 μ thick, stupose, brownish-yellow, composed of closely woven, gelified hyphae, becoming smaller next the gleba; gleba white becoming yellowish and finally Sudan brown in alcohol, cavities small and long, soon filled with spores; septa very thin, later yellowish, composed of compactly woven, gelified hyphae 2 μ in diameter; basidia clavate, short, paraphyses shorter; sterigmata as long as the diameter of the mature spore or longer; spores colorless, becoming yellowish-brown, 10–13 μ in diameter, with large blunt spines.

Under birch. Hessen-Nassau, Germany, and Oregon. July to September, mostly in August.

The specimen studied was collected in the type locality twelve years later than the original specimen but three years before the species was described and was determined by Hesse.

GERMANY: Hessen-Nassau, Altmorschen, *E. Hesse*, VII/88; Aue, *E. Hesse*, V/89 (both Hesse and Dodge).

OREGON: Marion County, Salem, *S. M. Zeller* 2186 (Zeller).

5. *HYDNANGIUM COMPACTUM* Harkness, Proc. Cal. Acad. Sci. Bot. III. 1: 250. 1899; Saccardo & Sydow in Sacc. Syll. Fung. 16: 255. 1902.—*not* Quélet, Ench. Fung. 247. 1886.

Type: cotype in Dudley Herb. at Leland Stanford Jr. Univ.

Fructification depressed-globose, 2 cm. in diameter, white becoming Sayal brown to tawny-olive in alcohol; peridium 120–130 μ thick, composed of hyaline, slender, compactly woven, gelified hyphae; gleba light ochraceous-buff, cavities empty; septa 80 μ thick, composed of hyaline, slender, compactly woven gelified hyphae; basidia oblong, $20 \times 4-5 \mu$, sterigmata short; spores very sparsely echinulate, with very small spines, 5–6 μ in diameter.

Under *Ceanothus*. California and Australia. May to June.

CALIFORNIA: Placer County, Auburn, *H. W. Harkness* 191, type (Stanford); Santa Clara County, *H. E. Parks* 1060 (Univ. Cal., Dodge, and Zeller); Guadalupe, *H. E. Parks* 153, 422, 801 (Univ. Cal., Dodge, and Zeller); Alma, *H. E. Parks* 162a (Univ. Cal., Dodge, and Zeller 1638).

AUSTRALIA: S. Australia, *J. B. Cleland* 2 (Cleland and Dodge).

6. *HYDNANGIUM Parksii* Zeller & Dodge, sp. nov.

Fructificationes magnae, 2–3 cm. diametro metientes, sphaericae, albae, fulvae conservatae, superficie glabra, basis sterilis columellaque non visae; peridium ad 640 μ crassitudine, hyphis subpericlinalibus dense contextum; gleba alba, “ochraceous buff” conservata, locellis parvis; septa 65–70 μ crassitudine, hyphis dense contexta; basidia cylindrica, bispora, $22 \times 6-7 \mu$; sporae 7.4–9 μ , hyalinae, minute echinulae.

Type: in Univ. Cal. Herb.

Fructifications large, 2–3 cm. in diameter, spherical, white becoming tawny in alcohol, surface smooth, no sterile base nor columella present; peridium up to 640 μ thick, composed of

densely woven, more or less periclinal hyphae; gleba white becoming ochraceous-buff in alcohol; cavities small; septa about $65-70\ \mu$ thick, of compactly woven, thin-walled hyphae; basidia cylindric, 2-spored, $22 \times 6-7\ \mu$; spores $7.4-9\ \mu$ in diameter, minutely echinulate, hyaline.

It is possible that this is still immature, in which case the thickness of the peridium and of the septa as given above is probably too great and the spore markings too minute.

CALIFORNIA: Santa Clara County, Guadalupe, *H. E. Parks 521* (Univ. Cal.).

7. *HYDNANGIUM GILKEYAE* Zeller & Dodge, *Ann. Mo. Bot. Gard.* 22: 371. 1935.

Type: in Oregon State Agr. Coll., Dodge, and Zeller Herbaria.

Fructifications oblong to subspherical, about $4.5 \times 3 \times 3\ \text{cm.}$, brittle; surface glabrous with innate reticulate veins, buff with brownish stains, drying pinkish-buff to tawny-olive, with the veins slightly darker; no sterile base showing in youngest specimens seen (1 cm. broad); peridium $150-200\ \mu$ thick, drying $70-85\ \mu$, of hyaline prosenchyma, appearing finely stupose when dried; gleba white to slightly creamy when fresh, drying pale orange-yellow to maize-yellow; cavities medium size; septa cream-color, hyaline *sub lente*, of loosely interwoven, large hyphae, scissile at angles, $35-40\ \mu$ thick; basidia 1-2-spored, clavate, protruding beyond the paraphyses; spores large, subspherical, mostly longer than broad, yellowish-brown, with large echinulae about $3-3.5\ \mu$ long, pedicellate, $18-22 \times 14.5-8.5\ \mu$ including the spines, epispore $0.7-1.0\ \mu$ thick.

Hypogeous, under *Corylus californicus*. Oregon. May.

OREGON: Linn County, near the Peoria Road, *Helen M. Gilkey*, type (Oregon State, Dodge, and Zeller 2334).

8. *HYDNANGIUM ALBUM* Harkness, *Proc. Cal. Acad. Sci. Bot.* III. 1: 251. 1899; Saccardo & Sydow in *Sacc. Syll. Fung.* 16: 255. 1902.

Type: cotype in Dudley Herb. at Leland Stanford Jr. Univ.

Fructifications spherical, 1 cm. in diameter, dirty white becoming brownish in alcohol; peridium simplex, $400\ \mu$ thick, composed of hyaline, slender, closely woven, branched hyphae;

gleba ochraceous; cavities minute, empty; septa $75\ \mu$ thick, composed of hyaline, slender, closely woven, branched hyphae; basidia clavate, $20 \times 6\ \mu$, sterigmata $6-7\ \mu$ long; spores dilute yellowish, minutely reticulate with short sharp spines, $11-15\ \mu$ in diameter.

In the forest. California. Spring.

In the outer part of the peridium and in the tramal tissues are dark brown bodies resembling latex organs, but the species has not been referred to *Arcangeliella* since no columella was reported in the type.

CALIFORNIA: Napa County, Calistoga, H. W. Harkness 178, cotype (Stanford).

9. *HYDNANGIUM PILA* Patouillard, Bull. Soc. Myc. France 26: 201. 1910; Saccardo & Trotter in Sacc. Syll. Fung. 21: 495. 1912.

Illustrations: Patouillard, Bull. Soc. Myc. France 26: 202, f. 2. 1910.

Type: Patouillard Herb. at Farlow Herb.

Fructifications depressed-globose to irregular, 2-3 cm. in diameter, white, reddening in air; peridium continuous above, often lacunose below, puberulent due to hyaline, cylindric cells of hyphae, $30-40\ \mu$ thick, dense and tenacious near the gleba, easily separable, mycelium white, fibrous, little developed; gleba firm, white, then reddish; no sterile base; septa composed of slender, cylindric filaments supporting a pseudoparenchymatous subhymenial layer; basidia obtuse and rounded at the summit, rapidly attenuated below into a cylindric portion, $30-35 \times 15-20\ \mu$, 4-spored, sterigmata short, pointed; spores colorless, later very pale tawny, spherical to slightly ellipsoid, $10-12\ \mu$ in diameter or $10-14 \times 9-11\ \mu$, echinulate, with a large oil drop.

Semi-hypogeous in oak woods. Central Europe. August.

GERMANY: Bayern, Ehrharting, E. Soehner (Soehner and Dodge).

FRANCE: Jura, Lepinay, N. Patouillard, type (Farlow).

10. *HYDNANGIUM CARNEUM* Wallroth in Dietrich, Fl. Reg. Boruss. [Fl. Königr. Preuss.] 7: no. 465. 1839; Tulasne, Fung. Hypog. 75. 1851; Winter in Rabenhorst, Kryptog.-Fl. Deutschl. ed. 2. 1: 877. 1883; DeToni in Sacc. Syll. Fung. 7: 175-176.

1888; Masee, Ann. Bot. 4: 37. 1889 [often cited as Monogr. Brit. Gast.]; Hesse, Hypog. Deutschl. 1: 82-83. 1891; Boudier, Icones Myc. 4: 98. 1905-1910; Th. M. Fries, Svensk Bot. Tidsskr. 3: 273-274. 1909; Hollós, Magyar. Földalatti Gombai, 97. 207-208. 1911; Th. C. E. Fries, Ark. f. Bot. 17^o: 12. 1922; Bataille, Bull. Soc. Myc. France 39: 192. 1923; † E. Fischer, Geobot. Inst. Rübel in Zürich, Veröffentl. 3: 576-578. 1925.

Octaviania carnea Corda, Icones Fung. 6: 36. 1854; Lloyd, Myc. Notes 67: 1139-1140. 1922, in part.

?*Octaviania carnea* Rodway, Papers & Proc. Roy. Soc. Tasmania 1923: 157. 1924; †Verwoerd, S. Afr. Jour. Sci. 22: 164. 1925.

Octaviania ? mollis De Notaris, Comment. Soc. Crittog. Ital. 1: 33. 1861; DeToni in Sacc. Syll. Fung. 7: 160. 1888.

Octavianina mollis O. Kuntze, Rev. Gen. Pl. 3²: 501. 1898.

Illustrations: Boudier, Icones Myc. 1: pl. 192; Bucholtz, Материалы къ морфологiи и систематикѣ подземныхъ грибовъ ... Издан. Естеств. Ист. Музея Графини Е. П. Шереметевой въ с. Михайловскомъ Московской Губ. 1: pl. 4, f. 27-28; Corda, Anleit. z. Stud. Myc. pl. D, f. 47: 11-13; Icones Fung. 6: pl. 7, f. 66; DeBary, Vergl. Morphol. d. Pilze, ed. 2, 67, f. 28; P. Hennings, Verh. Bot. Ver. Prov. Brandenburg 40: pl. 1, f. 18; Hesse, Hypog. Deutschl. 1: pl. 2, f. 18-19; pl. 5, f. 16; Istvanffy, Ber. Deutsch. Bot. Ges. 13: pl. 37, f. 49; Masee, Ann. Bot. 4: pl. 1, f. 14; Nees von Esenbeck, Th. & A. Henry, Syst. d. Pilze 1: pl. 27, f. 1-6; Petri, Rendic. Cong. Bot. Palermo, 148-149; Nuovo Giorn. Bot. Ital. N. S. 9: pl. 14; Roumeguère, Cryptog. Illustr. f. 374b; Ruhland, Bot. Zeit. 59: pl. 7, f. 25-30; Tulasne, Fung. Hypog. pl. 21, f. 3; Van Bambeke, Mem. Acad. Roy. Belg. 54: pl. 1-3.

Type: Bot. Mus. Berlin, Kew, and Paris. The type distribution of *Octaviania mollis* De Notaris in Erb. Critt. Ital. 1052.

Fructifications spherical or oblately spheroidal, pale flesh-color, smooth; no columella nor sterile base seen; peridium 150-270 μ thick, compact, fibrous, stupose; gleba very pale, drying brownish, brittle, cavities irregular, medium size; septa 20-28 μ thick between hymenial layers, about 55 μ to tops of paraphyses, stupose, composed of slender gelified hyphae;

basidia 2-spored, projecting above hymenium, $18-20 \times 10-13 \mu$; sterigmata $5-6 \mu$ long; cystidia large, smooth, hyaline; spores spherical, echinulate (echinulae plus exospore about 3μ), averaging 16 echinulae on median limb of circle, dilute honey-colored *en masse*, hyaline singly, $9.5-14 \mu$ in diameter (averaging about 16μ including echinulae).

Europe and America. October.

There is a trace of a sterile base in Rabenhorst, Fung. Eur. 675.

EXSICCATI: Erb. Critt. Ital. 1052, under *Octaviania mollis*; Rabenhorst, Fung. Eur. 675; Herb. Viv. Myc. 1318; Sydow, Mycoth. Marchica, 3726; de Thümen, Mycoth. Univ. 109.

FINLAND: Helsingfors, Bot. Gard., W. Nylander (Paris).

SWEDEN: Upsala, Th. M. Fries & E. Fries, in Rabenhorst, Fung. Eur. 675 (copy in Farlow); Bot. Trädgård, Th. M. Fries, 1866 (Upsala).

GERMANY: Schlesien, L. Becker, in de Thümen, Mycoth. Univ. 109 (Lloyd Mus. and Mo. Bot. Gard.); Brandenburg, Grünewald, F. Klotzsch, type (Berlin, Kew, and Paris); Berlin, P. Hennings, in Sydow, Mycoth. Marchica, 3726 (copies in Farlow, Lloyd Mus. 0234, and another specimen with same date, Lloyd Mus. 4149, and Dodge, also as *v. caldariorum*, Berlin); Klotzsch (Kew); Bayern, Wolftratschau, E. Soehner 724 (Soehner, Berlin, and Dodge).

AUSTRIA: Niederösterreich, Schneeberggebiet, F. von Hoehnel (von Hoehnel Herb. B2603 at Farlow).

ITALY: Trentino, G. Bresadola, Nov. 1894 (Upsala); Genova, F. Baglietto, in Erb. Critt. Ital. 1052, under the name *Octaviania mollis* De-Notaris, type! (copies in Farlow and Lloyd Mus.); Roma, O. Mattiolo (Lloyd Mus.).

FRANCE: Alpes Maritimes, Antibes, Poirault (Farlow, Lloyd Mus. 6039, and Dodge); Golfe Jouan, L. Rolland, Feb. 1900 (Paris).

HOLLAND: Amsterdam, Oudemans 307 (Upsala).

SCOTLAND: Glasgow Botanical Garden, Dickson, Oct. 1873 (Berkeley Herb. at Kew); Edinburgh (M. C. Cooke Herb. at Kew).

PORTUGAL: Lisbon, C. Torrend, Dec. 1907 (Paris as *f. minor*).

MASSACHUSETTS: Cambridge, H. von Schrenk (Mo. Bot. Gard. 1607); H. Webster (Farlow).

OREGON: Benton County, Corvallis, S. M. Zeller 2566; Linn County, Peoria, S. M. Zeller 2588 (both Zeller).

CALIFORNIA: Alameda County, Berkeley, E. A. Harper, 3 collections (N. Y. Bot. Gard.); Dale Parks & H. E. Parks 390 (Univ. Cal., Dodge, and Zeller); Santa Clara County, Saratoga, H. E. Parks 496 (Univ. Cal.); Alma, H. E. Parks 210, 152 (Univ. Cal., Dodge, and Zeller); Guadalupe Mines, H. E. Parks 435 (Univ. Cal., Dodge, and Zeller).

JAMAICA: Cinchona, W. A. & Edna L. Merrill 498 (N. Y. Bot. Gard. and Dodge).

URUGUAY: Montevideo, Miguelete, G. Herter 86821 (Dodge).

10a. var. PURPUREUM Petch, Ann. Roy. Bot. Gard. Peradeniya 7: 78. 1919.

Type: At Peradeniya and Kew Herbaria.

Fructification 1.0×0.7 cm., reniform, drying wrinkled, fawn-color to Natal brown; peridium $110-120 \mu$ thick, stupose, composed of gelified strands of dark brown hyphae as in *H. Archeri*; gleba tawny-olive to isabella-color, cavities large, empty; septa 20μ thick between hymenia, of slender, compact hyphae; basidia soon collapsing and evanescent, sterigmata long; spores hyaline or nearly so, spherical, $10-11 \mu$ in diameter, with slender, short spines about 24 per great circle.

Known only from the type locality.

The position of this variety is uncertain. In peridial characters it seems closer to *H. Archeri*, while its spores are suggestive of *H. carnea* or some species of *Arcangeliiella*.

Ceylon: Hakgala, T. Petoh 5480 type, 6438 (Peradeniya, Kew, and Dodge).

11. *HYDNANGIUM PUSILLUM* Harkness in Zeller & Dodge, Ann. Mo. Bot. Gard. 22: 372. 1935.

Type: in Dudley Herb. at Leland Stanford Jr. Univ.

Fructifications 1 cm. in diameter, cinnamon-brown; sterile base prominent, ending in a hemispherical knob at top and prolonged below into a short, slender stipe; peridium about 200μ thick, composed of thin-walled, hyaline, parallel hyphae; gleba buckthorn-brown; cavities large, irregular, empty; septa 100μ thick, composed of thin-walled, slender, hyaline hyphae, beginning to gelify; basidia broadly clavate, with two sterigmata $3-4 \mu$ long; spores spherical, 15μ in diameter, with prominent, long, slender spines.

CALIFORNIA: *H. W. Harkness 282*, type (Stanford).

12. *HYDNANGIUM LUTEOLUM* Harkness, Proc. Cal. Acad. Sci. Bot. III. 1: 251. 1899; Saccardo & Sydow in Sacc. Syll. Fung. 16: 255. 1902.

Type: cotype in Dudley Herb. at Leland Stanford Jr. Univ.

Fructifications small, irregular, white turning brown; peridium $1200-1300 \mu$ thick, composed of thin-walled, very slender, closely woven hyphae; gleba orange-yellow; cavities small, empty; septa $35-40 \mu$ thick, composed of coarse, gelified hyphae; basidia pyriform, $35-40 \times 8 \mu$, sterigmata short; spores

spherical, 12 μ in diameter, with small short spines not very closely placed, pedicellate.

In somewhat sandy soil beneath *Libocedrus decurrens*. California. July.

CALIFORNIA: Placer County, Alta, H. W. Harkness 100, cotype (Stanford).

13. *HYDNANGIUM ARCHERI* (Berkeley) Zeller & Dodge, Ann. Mo. Bot. Gard. 22: 371. 1935.

Octaviania Archeri Berkeley in J. D. Hooker, Bot. Antarctic Voy. III. Fl. Tasmaniae 2: 263-265. 1859; DeToni in Sacc. Syll. Fung. 7: 160. 1888; Cooke, Handbook Austral. Fungi, 246. 1892; Rodway, Papers & Proc. Roy. Soc. Tasmania 1911: 25. 1912.

Octavianina Archeri O. Kuntze, Rev. Gen. Pl. 3²: 501. 1898. Type: in Kew Herb.

Fructifications obovate, drying 7-8 mm. in diameter, chocolate to burnt umber, sterile base large (fide Berkeley); peridium highly gelified, thin, 60-80 μ thick, composed of interwoven strands of coarse, parallel hyphae; gleba deep olive-buff to dark olive-buff, hard, cartilaginous; cavities large, polygonal, empty; septa chocolate, cartilaginous, 30-40 μ thick, composed of slender, gelified, parallel, brown hyphae; basidia not evident on account of the collapse of the hymenium; spores spherical, with long slender equal spines 24 per great circle, 2-3 μ long, spores without spines 12-14 μ in diameter.

On sandy ground. Tasmania, Australia, and New Zealand.

Both Oregon specimens are too young for certain determination.

TASMANIA: *Archer*, type (Kew); Hobart, L. Rodway 118 (Kew), 087, 1108 (Lloyd Mus. and Dodge).

SOUTH AUSTRALIA: Morialta, J. B. Cleland 11 (Cleland and Dodge); Mt. Lofty, J. B. Cleland 12 (Cleland and Dodge).

NEW ZEALAND: Colenso 1480 (Kew); Invercargill, J. B. Cleland 9 (Cleland and Dodge).

OREGON: Benton County, Corvallis, S. M. Zeller 7254 (Zeller); H. P. Barsz (Zeller 8183).

14. *HYDNANGIUM AURANTIACUM* Heim & Malençon, Treb. Mus. Cienc. Nat. Barcelona 15 [Ser. Bot. 3]: 69-74. 1934.

Hydnangium carotaecolor Codina & Font-Quer, Cavanill. 3: 169-170. 1931.

Illustrations: Heim & Malençon, Treb. Mus. Cienc. Nat. Barcelona 15 [Ser. Bot. 3]: 70, f. 16.

Type: not seen by us, probably in Paris or Barcelona.

Fructifications 1.5–2 cm. in diameter, subspherical, wrinkled, rough, from yellow to orange (jaune orangé, K, Code 136, 141); peridium thin, arachnoid, absent in places, composed of yellow (Code 161) fibres; no columella or sterile base, although the base is provided with a tuft of rooting whitish or yellow fibrils, mycelium yellow; gleba dense, bright yellow (orange safrané, Code 131), cavities small, crowded; septa comparatively thick; basidia clavate, cylindric or obconic, $38-40 \times 8-10 \mu$, with 2–4 sterigmata $3.5-4 \times 1.2-1.6 \mu$; spores spherical or somewhat obovate, $11-16 \mu$ in diameter, with two walls and a thick epispore composed of terete, obtuse tubercles 1.5μ long arranged singly or in rows or joined by an imperfect reticulum, pale yellow, often with remains of the sterigma $3-4$ (-6) μ long, 2μ in diameter.

In wooded moist ravine facing north, under *Quercus Ilex*. Montserrat. October.

15. *HYDNANGIUM MONOSPORUM* Boudier & Patouillard, Jour. de Bot. [Morot] 2: 445. 1888; Patouillard, Tab. Anal. Fung. 7: 71. 1889; Saccardo, Syll. Fung. 9: 280–281. 1891; Boudier, Icones Myc. 4: 98–99. 1905–1910.

Octaviania monospora Lloyd, Myc. Notes 67: 1141. 1922.

Illustrations: Boudier, Icones Myc. 1: pl. 193; Patouillard, Tab. Anal. Fung. f. 692.

Type: cotype in Lloyd Museum.

Fructifications ovate-pyriform, irregularly depressed above, 3–4 cm. in diameter, ochraceous-tawny, somewhat papillate, squamulose at the surface; peridium $150-220 \mu$ thick, composed of parallel, hyaline hyphae; gleba firm, white, becoming yellowish and tawny where wounded; cavities small, empty; septa $30-50 \mu$ thick, composed of loosely interwoven, hyaline hyphae $3-5 \mu$ in diameter; basidia oblong-clavate, $30-40 \times 12 \mu$, with a single long sterigma tapering above; spores brownish, spherical, minutely echinulate, appearing smooth under low power, appendiculate, uniguttulate, $15-16 \mu$ in diameter; odor of pine-apples.

In clay soil. Germany and southern France.

GERMANY: Bayern, München, *E. Soehner 1060* (Soehner and Dodge).

FRANCE: Nice, *J. Barla*, cotype (ex Boudier Herb. in Lloyd Mus. 5343, Dodge, Patouillard Herb. at Farlow, and Upsala, com. *Bresadola* sub *H. candidum*).

16. *HYDNANGIUM AURANTIUM* (Harkness) Zeller & Dodge, *Ann. Mo. Bot. Gard.* 5: 30. 1918.

Rhizopogon aurantius Harkness, *Proc. Cal. Acad. Sci. Bot.* III. 1: 257. 1899; Saccardo, *Syll. Fung.* 16: 251. 1902.

Type: cotype in Dudley Herb. at Leland Stanford Jr. Univ.

Fructifications subspherical, solitary, 1–2 cm. in diameter, dirty white drying yellowish tawny to Mars brown, dark brown in alcohol; peridium 160–280 μ thick, homogeneous, of fine interwoven hyphae which become gelified at maturity, hyaline, with outer layer about 50–60 μ thick, of very compact, more or less erect, fine hyphae becoming brown; gleba orange when fresh, drying warm buff to ochraceous-buff or pale orange-yellow, cavities subglobose to irregular, empty; septa 30–60 μ thick, composed of slender hyphae, compactly interwoven, becoming scissile; basidia clavate, hyaline, 2-spored, 20–35 \times 8–10 μ , sterigmata 5–7 μ long; paraphyses cylindrical, septate; cystidia capitate with narrow necks, 48–52 \times 11–14 μ ; spores subglobose to obovoid, pediculate, 8.5–12 \times 11–14 μ , dilute olivaceous, finely echinulate-alveolate, exospore about 1–1.5 μ thick; odor pleasant as of certain polypores.

Hypogeous, in open coniferous woods. Western Washington, Oregon, and California. May to October.

This species is hunted by pine squirrels and other rodents.

WASHINGTON: Jefferson County, Quinault, *C. A. Brown & C. H. Kauffman* (Univ. Mich. and Zeller).

OREGON: Benton County, 7 miles west of Alsea, *S. M. Zeller 1960* (Zeller); Coos County, Sunset Beach, near Cape Arago Lighthouse, *N. L. Gardner 408* (Univ. Calif., Dodge, and Zeller).

CALIFORNIA: Marin County, Mt. Tamalpais, *H. W. Harkness 74*, cotype (Stanford); Santa Clara County, Saratoga, *H. E. Parks 1142 & C. W. Dodge 1152* [immature] (Dodge).

17. *HYDNANGIUM MISTIFORME* (Mattiolo) Zeller & Dodge, *Ann. Mo. Bot. Gard.* 22: 372. 1935.

Martellia mistiformis Mattiolo, *Malpighia* 14: 78–82. 1900; Saccardo & Sydow in *Sacc. Syll. Fung.* 16: 252. 1902.

Illustrations: Mattiolo, *Malpighia* 14; *pl. 1, f. 1-4*.

Type: probably in Mattiolo Herb., a portion in Patouillard Herb. at Farlow. Herb.

Fructifications spherical and irregular, about 1 cm. in diameter, olivaceous-white; peridium smooth, easily separable, variable in thickness, composed of gelified compact hyphae, the outer ones enclosing grains of sand; gleba rather firm, umber to chestnut; cavities small, irregular, gyrose with a tendency to arise from the sterile base; septa cottony-filamentous, scissile; basidia short-cylindric, 35-40 μ long, arising from subhymenial pseudoparenchyma, 4-spored; sterigmata slender, 4-5 μ long; spores spherical or slightly ellipsoidal, about 10 μ in diameter, umber, slightly echinate.

ITALY: Sardinia, Orune, *U. Martelli*, type (Patouillard Herb. at Farlow).

18. *HYDNANGIUM THAXTERI* Zeller & Dodge, *Ann. Mo. Bot. Gard.* 22: 372. 1935.

Type: in Farlow Herb. at Harvard Univ.

Fructifications spherical, color of crushed strawberries, drying capucine-yellow; columella scarcely more than thickened septum branching and disappearing in the middle of the fructification; peridium 125-130 μ thick, outer layer 30 μ thick, of closely woven, slender hyphae, and inner layer 100 μ thick, of larger, more loosely woven, periclinal hyphae; gleba orange-buff to light ochraceous-buff; cavities minute; septa 50-60 μ , of slender interwoven hyphae, subhymenium pseudoparenchymatous; basidia short-cylindric; sterigmata long; spores 7-8 μ in diameter, spherical, about 20-24 slender spines per great circle.

This species was found growing with *Rhizopogon occidentalis* under leaves on a dry hilltop above Concepción. Thaxter states "Color dirty cream running to crushed strawberry red." Since we have not seen *R. occidentalis* with more than pale pink tints, we have assumed that the deeper color mentioned applied to our species.

CHILE: Concepción, *E. Thaxter*, Nov. 1905, type (Farlow).

19. *HYDNANGIUM purpureum* (Coker & Couch) Zeller & Dodge, *comb. nov.*

Octaviania purpurea Coker & Couch, Gast. Eastern U. S. & Canada, 50. 1928.

Illustrations: Coker & Couch, Gast. Eastern U. S. & Canada, pl. 30, 31, 111.

Type: in Univ. North Carolina Herb., a portion in Dodge Herb.

Fructifications 0.6–2.5 cm. in diameter, drying 0.4–1.6 cm., oblatelly spheroidal to irregularly lobed, with branched rhizomorphs, white turning vinaceous to deep vinaceous on exposure or wounding, drying vinaceous, without sterile base or columella; peridium 1–2 mm. thick, drying 150–450 μ thick, separable, composed of slender, densely woven hyphae 3–4 μ in diameter, and a few much larger, thick-walled hyphae 11–16 μ , often ending in large spherical cells; gleba white at first becoming olive-brown to deep blackish-brown; septa white, 30–40 μ thick, of slender gelified hyphae with groups of cavities separated by much thicker septa; basidia 20–25 \times 7.4–11.2 μ when young, sending up an epibasidium 4.4–5.5 μ in diameter, bearing a single spore so that the mature basidium is flask-shaped, 30–44 \times 5.5–7.8 μ and early collapsing; spores broadly ellipsoidal, 9.5–12.5 μ in diameter, thick-walled, with large warts.

North Carolina. July and August.

The systematic position of this species is not clear, and it is with hesitation that we have referred it to *Hydnangium*. We have seen no trace of sterile base and columella. The large thick-walled hyphae of the peridium are very suggestive of lactiferous ducts, but the contents do not stain more deeply with eosin as do the contents of latex hyphae in *Arcangeliella*. The basidium with the differentiation of epibasidium is unusual in the present state of our knowledge, although suggestions of this kind of development are present in some of the Bornean species of *Arcangeliella*.

NORTH CAROLINA: Chapel Hill, Battle's Branch, J. N. Couch, type (Univ. N. Car. 7468, and Dodge).

20. *HYDNANGIUM HESSEI* (O. Kuntze) Zeller & Dodge, Ann. Mo. Bot. Gard. 22: 371. 1935.

Octavianina Hessei O. Kuntze, Rev. Gen. Pl. 3²: 501. 1898.

Octaviania Hesseana Saccardo & Sydow in Sacc. Syll. Fung. 14: 267. 1899.

Octaviania mutabilis Hesse, Hypog. Deutschl. 1: 77-78. 1891; Sacc. Syll. Fung. 11: 169. 1895—not *Octaviania mutabilis* Roumeguère, Rev. Myc. 7: 23. 1885.

Type: location not certainly known to us, but material so determined by Hesse collected in July, 1891, is in the Bot. Inst. Univ. Marburg.

Fructifications 1 cm. in diameter, white then yellowish-white, and finally dark brown flecked with yellowish-white, becoming greenish in light as in *A. asterosperma*, later dark brown or violet; peridium about 200 μ thick, easily separable in both fresh and dry material, fibrous to woolly, composed of hyaline, parallel hyphae of variable thickness next the gleba, hyphae thicker, more loosely woven and brown, thin-walled next the outside; gleba snow-white at first becoming dark brown, fragile at first becoming cartilaginous; cavities long, irregular and filled with spores; septa composed of loosely woven, septate hyphae and slender subhymenial hyphae; basidia short, clavate, paraphyses shorter than the basidia, sterigmata filiform; spores very dark brown, 12-13 μ in diameter, coarsely echinate.

Germany. July and September.

GERMANY: Hessen-Nassau, *E. Hesse*, July 1891 (Hesse); Bayern, München, *E. Soehner* 961 (Soehner and Dodge).

21. *HYDNANGIUM LANIGERUM* (Hesse) Zeller & Dodge, Ann. Mo. Bot. Gard. 22: 372. 1935.

Octaviania lanigera Hesse, Hypog. Deutschl. 1: 79-80. 1891; Sacc. Syll. Fung. 11: 169. 1895.

Octavianina lanigera O. Kuntze, Rev. Gen. Pl. 3²: 501. 1898.

Illustrations: Hesse, Hypog. Deutschl. 1: pl. 6, f. 7-8.

Type: location unknown to us, but authentic material in Farlow Herb. at Harvard Univ.

Fructifications 2.5 \times 2 \times 2 cm., reniform, pure white; fibrils snow-white, small, scanty; peridium 600-700 μ thick, loose, stupose to almost byssoid, composed of large, hyaline, septate hyphae 8-9.5 μ in diameter, sterile base broadly pulvinate;

gleba tawny to russet; septa 100–150 μ thick, composed of loosely woven, septate, branched hyphae 10 μ in diameter; basidia cylindric, 2–3-spored; spores spherical, 12–14 μ in diameter, tawny, with broad echinulae (10–14 per great circle) 2–3 μ long, walls 1–1.5 μ thick.

Under *Betula*. Germany. Early autumn.

GERMANY: Hessen-Nassau, Altmorschen, *E. Hesse* (Farlow).

22. *HYDNANGIUM JAVANICUM* P. Hennings, Beiblatt zur Hedwigia 40: (27). 1901; Saccardo & Sydow in Sacc. Syll. Fung. 16: 255. 1902; von Höhnelt, K. Akad. Wiss. Wien, math.-naturw. Kl. Sitzungsber. Abt. I. 117: 1017. 1908.

Type: in Bot. Mus. Berlin.

Fructifications subspherical, 1.8–2.1 \times 1.4–1.7 cm., drying 0.7–1.0 cm. in diameter, pale flesh-color, surface smooth or slightly tomentose; peridium about 140 μ thick, separable, of large, loosely woven hyphae 4 μ in diameter embedded in a gel; gleba flesh-color becoming brown, elastic, cavities minute, sinuous; septa about 40 μ thick, composed of slender, compactly woven, gelified hyphae; basidia clavate, 20–30 \times 5–8 μ , 4 sterigmata; spores spherical, densely echinate, brownish-olivaceous, 15–18 μ in diameter, with the spines yellowish, 3–4 \times 0.5–0.7 μ ; weak odor of rancid almonds.

JAVA: Tjibodas, *M. Fleischer*, 11 Oct. 1900, type (Berlin).

23. *HYDNANGIUM NIGRICANS* Kalchbrenner, Grevillea 10: 107. 1882; Saccardo, Syll. Fung. 11: 172. 1895.

Type: in Kew Herb. and in Bot. Mus. Berlin.

Fructifications 1.5 \times 2 cm., depressed-globose, drying black, smooth, no trace of sterile base or columella in sliced fructification; peridium 260–270 μ thick, composed of large, thin-walled prosenchyma; gleba ochraceous-tawny, cavities small; septa thin, 14–15 μ between hymenia (in dried material), appearing as slender, irregular, gelified hyphae but perhaps similar to the peridium, badly collapsed; basidia about 30 \times 11 μ , collapsing in the upper half on the separation of the spore; spores 12–19 μ in diameter, dark brown, with closely set, conical spines on a thick epispore.

Under *Acacia* in grassy fields. South Africa.

One should note that Kalchbrenner also cites *Macowan 1211* as *Macowanites agaricinus*.

SOUTH AFRICA: Somerset East, near Mt. Boschberg, *P. Macowan 1211*, type (Kew and Berlin).

24. *HYDNANGIUM TUBERCULATUM* (Hesse) Zeller & Dodge, *Ann. Mo. Bot. Gard.* **22**: 373. 1935.

Octaviania tuberculata Hesse, *Hypog. Deutschl.* **1**: 75-77. 1891; *Sacc. Syll. Fung.* **11**: 169. 1895.

Octavianina tuberculata O. Kuntze, *Rev. Gen. Pl.* **3**²: 501. 1898.

Illustrations: Hesse, *Hypog. Deutschl.* **1**: *pl. 7, f. 14; pl. 9, f. 16-24.*

Type: location unknown to us. Specimen examined from type locality collected two years after the type, determined by the author before the original description was published, but not cited.

Fructifications 1.3×2 cm., depressed-globose, very irregular, deeply and thickly furrowed on the upper surface, white at first then yellowish, and finally brown vinaceous-buff to avellaneous in alcohol; sterile base disappearing at maturity; peridium 900-1000 μ thick, not separable, fibrous, composed of thin-walled, undulating, loosely woven, brownish hyphae 6-7 μ in diameter, becoming white next the gleba, woolly in the deep furrows; gleba mummy-brown, cavities very irregular, partially filled with spores; septa thin toward the outside, 90-100 μ thick, thicker between the cavities in the center of the fructifications, composed of large, thin-walled, septate hyphae 4-5 μ in diameter (almost pseudoparenchyma), white finally becoming light brown; basidia clavate with 3-4 sterigmata, filiform, half the length of the spores, paraphyses shorter, slenderer, and septate; spores with spiny, thick exospore, dark brown, 12-13 μ in diameter; odorless.

Under *Fagus sylvatica*. Hessen-Nassau, Germany. September and October.

GERMANY: Hessen-Nassau, Michelbach, *E. Hesse*, X/88 (Hesse).

25. *HYDNANGIUM DENSUM* Rodway, *Papers & Proc. Roy. Soc. Tasmania* **1919**: 112. 1920; **1923**: 160. 1924; Trotter in *Sacc. Syll. Fung.* **24**: 1328. 1928.

Hydnangium Mouchettii herb. nom.

Type: in Rodway Herb. at Tasmanian Museum. Type of *H. Mouchettii* in Herb. Dept. Agr., Pathologist's Branch, Victoria.

Fructifications depressed-globose, 1–1.5 cm. in diameter when dry, pale ochre when fresh becoming cinnamon-buff to tawny-olive; peridium about 450 μ thick when dry, stupose, composed of thick-walled, brown hyphae 4–5 μ in diameter; gleba mummy-brown where cut, gray where fractured, resembling a *Melanogaster*, cavities filled with spores, polyhedral; septa very variable in thickness, composed of loosely woven, gelified, hyaline hyphae 2 μ in diameter, more compact in the subhymenium; basidia not seen; spores very dark brown, spherical, densely echinate, 10–11 μ in diameter.

The systematic position of this species is wholly obscure. Basidia if present are evanescent. From its spore-filled cavities it might be placed in *Melanogaster* or *Chondrogaster*, although its spore shape is closer to the dark-spored species of *Arcangeliiella*. It is even possible that it belongs in the Sclerodermataceae near *Pompholyx*.

AUSTRALIA: South Australia, Aldgate, [*Mouchette?*] (sub *Hydnangium Mouchettii* in Herb. Dept. Agr., Pathologist's Branch No. after 1444).

TASMANIA: Mt. Nelson Range, L. Rodway, type (Rodway).

26. *HYDNANGIUM LUTEUM* (Hesse) Zeller & Dodge, Ann. Mo. Bot. Gard. 22: 372. 1935.

Octaviania lutea Hesse, Jahrb. f. wiss. Bot. 16: 255. 1885; Hypog. Deutschl. 1: 74–75. 1891; DeToni in Sacc. Syll. Fung. 7: 491. 1888; Hollós, Magyar. Földalatti Gombai, 96, 207. 1911.

Illustrations: Hesse, Jahrb. f. wiss. Bot. 16: pl. 6, f. 7–9; Hypog. Deutschl. 1: pl. 6, f. 5–6; pl. 7, f. 49.

Type: in Upsala and Farlow Herbaria.

Fructifications up to 2.5–3 cm. in diameter, irregular to subglobose, becoming auburn, chestnut, or Mars brown in alcohol, surface smooth, fibrillose-villous, with lighter, almost white patches due to thicker portions of the peridium; peridium 300–400 μ thick in the thicker portions, 150–200 μ in the thinner, loosely stupose, composed of large, thin-walled, hyaline hyphae

as in *Rhizopogon maculatus*, fascicles of erect hyphae on the surface giving the villous appearance; sterile base not seen in older specimens, but evident in the younger; gleba cheesy in consistency, cinnamon to tawny-olive, cavities small, irregular, filled with spores; septa 40–50 μ thick, stupose, composed of parallel hyphae 3–4 μ in diameter; basidia 2–4-spored, clavate, 24–28 \times 12–13 μ ; spores 12–13 μ (15–16 μ with echinulae), tawny, with 12–18 spines on the periphery of an optical section of the spore.

Under birches. Germany. Summer.

GERMANY: Hessen-Nassau, Altmorschen, *E. Hesse*, type (Upsala and Farlow).

27. *HYDNANGIUM SOEHNERI* Zeller & Dodge, Ann. Mo. Bot. Gard. 22: 372. 1935.

Type: in Soehner, Zeller, and Dodge Herbaria.

Fructifications spherical to reniform, drying 0.6 \times 0.9 cm., very dark brown to black, no sterile base or columella seen; peridium 50–60 μ thick, of small-celled, gelified prosenchyma; gleba Sudan brown, cavities relatively large, empty; septa thin, somewhat scissile, of large, thick-walled, brownish, loosely woven hyphae; basidia large, cylindrical, soon collapsing; spores ellipsoidal, 15.4–18.2 \times 12.4–14 μ , dark brown.

GERMANY: Bayern, Wolfratshausen, Pupplinger Heide, *E. Soehner*, type (Soehner, Zeller, and Dodge).

28. *HYDNANGIUM CEREUM* Soehner, Kryptog. Forsch. 1: 394. 1924.

Type: in Soehner Herb. and portion in Dodge Herb.

Fructifications 2–3 cm. in diameter, spherical, smooth, glabrous, very firm, white then wax-yellow, often becoming tawny or Van Dyck brown in old age, drying tawny, base slightly rugose or depressed, no rhizomorphs; peridium thin, up to 100 μ thick; gleba white, later slightly yellowish, browning on exposure to air, tawny at maturity, drying ochraceous-buff, cavities small but conspicuous; spores spherical, hyaline at first, becoming slightly tawny, 10–15 μ , mostly 12.5 μ , in diameter, exospore slightly spinose when young, becoming coarsely echinate; odor slight when fresh, when dry, like that of apples.

In loam in oak forest. Ehrharting near Mühldorf. Very rare.

GERMANY: Bayern, Ehrharting bei Mühldorf am Inn, E. Soehner 527, type (Soehner and Dodge).

EXCLUDED SPECIES

1. *LEUCOPHLEBS Clelandi* (Rodway) Zeller & Dodge, comb. nov.

Hydnangium Clelandi Rodway, Papers & Proc. Roy. Soc. Tasmania 1924: 159. 1925.

Type: in Rodway Herb. at Tasmanian Museum.

Fructifications irregularly spherical, 1–2 cm. in diameter, whitish-ochre, drying light yellowish-olive to olive-yellow; peridium thin, membranous, white, continuous with the trama, outer 110 μ of large hyphae 7–8 μ in diameter, with gelified walls, inner 150 μ of slender, thin-walled hyphae 2–3 μ in diameter, densely interwoven; gleba dull brown-clay to umber, becoming browner with age, drying snuff-brown to bister, cavities about 1 mm., not contorted but densely crowded with spores; septa 14–15 μ thick, of densely woven, slender hyphae; spores pale yellow, globose, smooth, becoming obscurely verrucose, 20–22 μ in diameter, very thick-walled, somewhat suggesting *L. magnata* Harkn.

The type, consisting of a single fructification, does not seem to be in condition to show how the spores are borne, as all trace of hymenium has disappeared. In spore characters and general texture of the fructification it seems much closer to *Leucophlebs* than to *Hydnangium*.

TASMANIA: Hobart, Cascade Valley, L. Rodway, type (Rodway).

2. *HYDNANGIUM MICROSPORIUM* Rodway, Papers & Proc. Roy. Soc. Tasmania 1919: 111. 1920; 1923: 160. 1924; Trotter in Sacc. Syll. Fung. 24: 1328. 1928.—not *Octaviania microsporium* Mattirollo, nom. herb. in Lloyd Mus.

Type: in Rodway Herb. at Tasmanian Museum.

After a study of the type, we agree with Cunningham that this species should be referred to *Lycoperdon Gunnii* Berkeley.

STEPHANOSPORA

Stephanospora Patouillard, Bull. Soc. Myc. France 30: 349. 1914.

The type species of the genus is *Hydnangium caroticolor* Berkeley.

Fructifications spherical or nearly so, without sterile base or columella; peridium thin and fragile; gleba fragile; basidia cylindrical; spores long-ellipsoidal, coarsely echinate, with a broad collar at the base surrounding the sterigma.

It is with some hesitation that we have recognized this genus which is very close to *Hydnangium* in most characters, but its spore is so distinct and we have seen nothing which suggests a transition between it and *Hydnangium*. At present only a single species from England and central Europe is known.

STEPHANOSPORA CAROTICOLOR (Berkeley) Patouillard, Bull. Soc. Myc. France 30: 349. 1914.

Hydnangium caroticolor Berkeley, Ann. & Mag. Nat. Hist. I. 13: 351-352. 1844; *Ibid.* I. 18: 76. 1846; Outlines British Fungol. 293. 1860; Tulasne, Fung. Hypog. 75. 1851; Winter in Rabenhorst, Krypt.-Fl. Deutschl. ed. 2. 1: 877-878. 1883; DeToni in Sacc. Syll. Fung. 7: 176-177. 1888; Massee, Ann. Bot. 4: 36-37. 1889 [often cited as Monogr. Brit. Gast.]; Hesse, Hypog. Deutschl. 1: 83-84. 1891; Patouillard, Bull. Soc. Myc. France 26: 203-204. 1910.

Octaviania caroticolor Corda, Icones Fung. 6: 36. 1854; Lloyd, Myc. Notes 67: 1141. 1922.

Illustrations: Berkeley, Outlines British Fungol. *pl.* 20, *f.* 1; Cooke, Handbook Brit. Fung. 1: 357; Corda, Icones Fung. 6: *pl.* 7, *f.* 65; Massee, Ann. Bot. 4: *pl.* 1, *f.* 6; Patouillard, Bull. Soc. Myc. France 25: 203, *f.* 3; Tulasne, Fung. Hypog. *pl.* 21, *f.* 4; Winter in Rabenhorst, Kryptog.-Fl. Deutschl. ed. 2. 1: 871.

Type: in Berkeley Herb. at Kew, and Broome Herb. at British Museum.

Fructifications oblong, about 2 cm. in diameter, slightly tomentose, pale orange-red [exactly like that of a fine carrot, Berkeley & Broome] when fresh, drying amber-brown to Argus

brown; peridium thin, fragile; gleba beautiful orange-red [Berkeley & Broome] when fresh, drying raw sienna, cavities small, empty; septa 10–14 μ thick, composed of parallel hyphae; basidia short-cylindric, sterigmata 3–4 μ long; spores long-ellipsoidal, with a smooth hyaline fold at the base, coarsely echinate, 8–13 \times 6–7 μ .

Central and western Europe.

GERMANY: Bayern, Kaufbeuren, *E. Soehner* 239 (Dodge, Zeller, and Berlin); Hessen-Nassau, Aue, *E. Hesse*, Aug. 1891 (Hesse).

FRANCE: Jura, Lépinau, *N. Patouillard*, Août, Oct. 1912 (Patouillard at Farlow).

SWITZERLAND: Bassecourt, *P. Konrad* (Lloyd Mus. 046); Zurich, *G. Winter* 1809 (Stanford and Berlin).

ENGLAND: *C. E. Broome* (Lloyd Mus. 0231.); Gloucestershire, near Clifton, *C. E. Broome*, type (Kew, Brit. Mus.); Leigh Wood, near Bristol, *C. E. Broome* 310 (ex Herb. J. W. Bailey in Brown Univ., Curtis Herb. at Farlow, and 4 collections Brit. Mus.); Dorsetshire, Swanage, Ballard Down, *C. E. Broome* (2 collections Brit. Mus., and Berlin).

ELASMOMYCES, ARCANGELIELLA, AND MACOWANITES¹

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Elasmomyces and *Arcangeliella* were erected by Cavares to receive those forms related to *Hydnangium* but having a columella. In *Elasmomyces* the gleba may pull away from the base of the substipitate columella at maturity, while in *Arcangeliella* the gleba remains attached to the columella although the peridium may break away from the base partially exposing the lower part of the gleba. *Arcangeliella* also has lactiferous ducts in the trama, the peridium, and the columella. These characters seem important from the standpoint of comparative morphology and are worthy of generic distinction. The lactiferous ducts at times are scant and may require careful staining. The study of the columella in fresh material is rather simple, but in dry herbarium specimens it may not show more than as a line. If whole or large sections of specimens are present they may be made to regain almost natural stature by soaking, rendering even a slight columella apparent and readily studied. When the fructifications have been sliced thin, as in many of the older collections, this character may be ambiguous.

Macowanites is similar to the above two genera in some respects, but for the most part the species are larger and are more pileate than in *Elasmomyces*. One species with lactifer-

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ous ducts in the fundamental tissues may be most closely allied to *Arcangeliiella*.

We have used the same color standards (Ridgeway) and in citing specimens studied have used the same abbreviations as in our other recent papers. Besides those whose aid was gratefully acknowledged in previous papers we are indebted for financial aid to the American Association for the Advancement of Science (grant in 1923 to the senior author), to the John Simon Guggenheim Memorial Foundation which appointed the junior author a fellow to Europe in 1930, and to the Science Research Fund of Washington University for a grant in 1933 to the junior author.

ELASMOMYCES

Elasmomyces F. Cavara, *Malpighia* 11: 414-428. 1897; *Rev. Myc.* 21: 23. 1899; Saccardo & Sydow in *Sacc. Syll. Fung.* 14: 258. 1899; Petri, *Fl. Ital. Cryptog.* 1^o: 29. 1909; Hollós, *Magyar. Földalatti Gombai*, 81-82, 201. 1911.

Secotium sect. *Elasmomyces* E. Fischer in Engler & Prantl, *Die Nat. Pflanzenfam.* I. 1^{**}: 300. 1900.

The type species of the genus is *Elasmomyces Mattirolanus* F. Cavara.

Fructifications subspherical when young, sometimes expanding like a small agaric button, but the gleba only slightly separating from the stipe, which is usually short and slender; peridium covering the gleba but pulling away around the base of the stipe, exposing the gleba below and sometimes flaking off irregularly on other parts of the fructification; gleba of anastomosing cavities; spores spherical, echinulate.

1. *ELASMOMYCES BORNEENSIS* (Petri) Zeller & Dodge, *Ann. Mo. Bot. Gard.* 22: 370. 1935.

Octaviania borneensis Petri, *Malpighia* 14: 128. 1900; Saccardo & Sydow in *Sacc. Syll. Fung.* 16: 248. 1902.

Illustrations: Petri, *Malpighia* 14: *pl. 2, f. 12, 19, 20; pl. 3, f. 4.*

Type: in *Ist. Bot. Univ. Firenze*.

Fructifications spherical to slightly elongate, attenuated below; surface dirty white, felt-like, covered with patches where

the peridium is thicker; columella penetrating beyond the center of the fructification; sterile base present; peridium about 1 mm. thick, not separable, similar in texture to the gleba, the outside hyphae larger, forming a loosely woven layer, irregular in thickness; gleba very dark, cavities very small; septa thick in comparison with the cavities, trama of hyphae irregularly traversing a gelatinous stratum; basidia cylindrical, 4-, rarely 2-spored, sterigmata short; spores spherical, yellow-greenish, 9–10 μ in diameter, spines similar to those of *Arcangeliella asterosperma*.

Sarawak, Borneo.

The presence of the columella and the hyphae being embedded in a gelatinous layer in the septa seem to indicate that this species may belong in *Arcangeliella*, near *A. vulvaria*, although no lactiferous ducts were found.

BORNEO: Sarawak, O. Beccari 1867, type (Univ. Firenze).

2. *ELASMOMYCES ECHINOSPORUS* Zeller & Dodge, Ann. Mo. Bot. Gard. 22: 370. 1935.

Macowanites echinosporus Zeller & Dodge, Ann. Mo. Bot. Gard. 6: 57–58. 1919.

Type: in Univ. Cal., Dodge, and Zeller Herbaria.

Fructifications subspherical to irregular, 1 \times 1.5 cm., even, smooth, very delicate salmon-color, becoming tawny-olive in alcohol; peridium thin, 90–120 μ thick, extending over the upper half of the fructification, consisting of hyaline pseudoparenchyma; stipe concolorous, about 5 mm. long and 2 mm. in diameter, stipose, of fine, hyaline hyphae; sterile base a conical projection of the stipe extending into the gleba but not percurrent; gleba covered above, exposed below, sinuate about the stipe, concolorous with the peridium, cavities minute, irregular; septa 60–80 μ thick (including hymenia), hyaline, composed of pseudoparenchymatous cells, not scissile; cystidia rare, clavate, apiculate, 9–10 \times 20–24 μ , hyaline; basidia small, cylindrical to clavate, 2–4-spored, 5–8 \times 18–22 μ ; spores spherical to broadly ovoid, hyaline, appendiculate, 6–8 μ in diameter, sparingly echinulate.

Hypogeous under *Quercus*. California. March.

CALIFORNIA: Alameda County, East Oakland, *N. L. Gardner 402*, type (Univ. Cal., Dodge and Zeller 1624).

3. *ELASMOMYCES MATTIROLANUS* F. Cavara, *Malpighia* 11: 426. 1897; *Rev. Myc.* 21: 23-24. 1899; Saccardo & Sydow in *Sacc. Syll. Fung.* 14: 258. 1899; Petri, *Fl. Ital. Cryptog.* 1^o: 30-31. 1909; Hollós, *Magyar. Földalatti Gombai*, 81-82. 201. 1911.

Secotium (Elasmomyces) Mattirolanum E. Fischer in Engler & Prantl, *Die Nat. Pflanzenfam.* I. 1^{**}: 301-302. 1900.

Illustrations: F. Cavara, *Malpighia* 11: *pl.* 7; *Rev. Myc.* 21: *pl.* 187, *f.* 1-5; E. Fischer in Engler & Prantl, *Die Nat. Pflanzenfam.* I. 1^{**}: 301-302. *f.* 150 *A-F*; Petri, *Fl. Ital. Cryptog.* 1^o: *f.* 6-7.

Type: in R. Ist. Bot. di Napoli, Mattirololo Herb., a portion in Dodge and Zeller Herbaria.

Fructifications 1.5-2.5 cm. in diameter, depressed-globose, resembling the young buttons of *Agaricus*, margin undulate, yellowish-white, pruinose; stipe short, thick, continued as a thick percurrent columella through the gleba, filamentous with islands of pseudoparenchyma; peridium 210-220 μ thick, outer hyphae slender and periclinal, gradually becoming larger and more prosenchymatous within; gleba drying tawny-olive to wood-brown, cavities large, empty; septa 110-120 μ thick, composed of slender, periclinal, loosely woven hyphae; basidia cylindric, 2-spored; spores slightly ellipsoidal, dilute straw-yellow, about $10 \times 7 \mu$, with slender spines.

Emergent under conifers. Italy and Oregon. (May in Oregon.)

ITALY: Vallombrosa, *F. Cavara*, type (R. Ist. Bot. di Napoli, Mattirololo Herb., Dodge, and Zeller); Firenze, *O. Mattirololo* (Patouillard Herb. at Farlow).

OREGON: Lincoln County, Waldport, *S. M. Zeller 7112* (Dodge and Zeller).

ARCANGELIELLA

Arcangelietta F. Cavara, *Nuov. Giorn. Bot. Ital.* N. S. 7: 117-128. 1900; Saccardo & Sydow in *Sacc. Syll. Fung.* 16: 255-256. 1902; Lloyd, *Myc. Notes* 7: 1142. 1922.

Octaviana Vittadini, *Monogr. Tuberac.* 15-20. 1831 (pro parte minore).

Octaviania Vittadini em. Corda, Anleit. z. Stud. Myc. 107, lxxxii. 1842; Icones Fung. 5: 26. 1842; Tulasne, Ann. Sci. Nat. Bot. II. 19: 376. 1843; Fung. Hypog. 77. 1851; Fries, Summa Veg. Scand. 436. 1849; Berkeley, Outlines Brit. Fungol. 292. 1860; Winter in Rabenhorst, Krypt.-Fl. Deutschl. ed. 2. 1: 878. 1884; De Toni in Sacc. Syll. Fung. 7: 158-161. 1888; Hesse, Hypog. Deutschl. 1: 71-81. 1891; E. Fischer in Engler & Prantl, Die Nat. Pflanzenfam. I. 1^{**}: 310. 1899, and ed. 2, 7a: 17. 1933; Hollós, Magyar. Földalatti Gombai, 95-96, 206-207. 1911; Lloyd, Myc. Notes 7: 1139-1142. 1922 (pro parte).

Octavianina O. Kuntze, Rev. Gen. Pl. 3²: 501. 1898 (pro parte).

Octaviana Rodway, Papers & Proc. Roy. Soc. Tasmania 1923: 157. 1924.

Gymnomyces Massee & Rodway, Kew Bull. Misc. Inf. 1898: 125. 1898; Saccardo & Sydow in Sacc. Syll. Fung. 16: 249. 1898; E. Fischer in Engler & Prantl, Die Nat. Pflanzenfam. I. 1^{**}: 557. 1900, and ed. 2, 7a: 14. 1933; Zeller & Dodge, Ann. Mo. Bot. Gard. 6: 54-56. 1919.

The type species of the genus is *Arcangeliella Borziana* F. Cavara. In 1831 Vittadini described seven species of *Octaviania* without designating the type. Six of these species have been universally referred by writers since to *Melanogaster* Corda, published the same year. Some of the type specimens have been lost and some of the species have not been collected and identified with Vittadini's species since. However, *O. variegata* Vitt. has had a continuous tradition and is well known, being the commonest in Italy, and may be considered the type of *Octaviania*.

Corda in 1842, and Tulasne the next year, attempted to transfer the name *Octaviania* to another group of hypogeous Gasteromycetes by selecting *O. asterosperma* (referred by us to *Arcangeliella*) as the type. A careful reading of Vittadini's descriptions and discussions shows that the principal character which he emphasized was the dark color of the spores, the same as Corda for *Melanogaster*, and that the shape of the spore and the distribution of basidia in the gleba were quite secondary characters to Vittadini. He specifically notes that *O. astero-*

sperma is aberrant in the genus because of its sterile base and the shape of its spores, the two characters used by Corda and Tulasne in their later work. Consequently we prefer to regard *Octaviania* as a synonym of *Melanogaster*. O. Kuntze in 1898 recognized this situation and proposed *Octavianina*, treating four species here placed in *Hydnangium* and four which we have treated as *Arcangeliella*. He failed to designate a type and apparently did not study specimens, basing his concept wholly on that of DeToni in Sacc. Syll. Fung. 7: 158-160. 1888. Any attempt to select a type must be arbitrary. One might choose *Octaviania asterosperma* and place all the species here treated as *Arcangeliella* in *Octavianina*, while if another species were chosen as the type species *Octavianina* would become a synonym of *Hydnangium*, which Kuntze also recognized as a separate genus. We prefer to overlook this name as a source of confusion. It has not been used to our knowledge since proposed by Kuntze.

Octaviana Rodway is evidently only an error in orthography and should not be given separate recognition.

Gymnomyces Masee & Rodway was based on *G. pallidus* and *G. seminudus* without designation of type. Clements & Shear, Gen. Fung. 356. 1931, selected *G. pallidus* as the type but gave no reasons for their choice. Since this species is described as having "no distinct peridium," while *G. seminudus* has a "delicate external downiness which may be considered as a very rudimentary peridium," and since the principal character in Masee & Rodway's generic description is "Peridium haud distinctum vel nullum," their choice is reasonable. Both species are here treated in *Arcangeliella*, most of whose species have a well-developed peridium even though at maturity it may be evanescent or easily dehiscent from the base or lower half of the fructification in several species. To recognize *Gymnomyces* for this group is also undesirable as it has been used for various groups of species and none of the essential characters has been ascribed to it. To adopt it would also be confusing. *Arcangeliella* was very carefully described with all the essential characters of the group and has had a continuous tradition since as additional species have been described. Therefore

we propose to recognize it (although arguments from a strict interpretation of the International Rules of Botanical Nomenclature might be brought for *Octavianina*) and recommend *Arcangeliella* to the next botanical congress as a *nomen conservandum*.

Fructifications gregarious, hypogeous or emergent, fleshy, lactiferous; peridium thin, especially below, where it reaches the base in young specimens but where it is often evanescent at maturity; columella usually percurrent, sometimes branched; base more or less sterile, usually attenuated into a stipe-like attachment to the rhizomorphs, generally lactiferous; gleba fragile or cheesy, lactiferous, cavities variable in size, often minute, irregular, radiating more or less from the columella and base; basidia 2-4-spored; cystidia sometimes present; spores spherical to ellipsoidal, echinulate to verrucose, often alveolate or somewhat reticulate.

KEY TO SPECIES OF ARCANGELIELLA

1. Spores smooth or very slightly wrinkled above, subspherical, 4-6 μ in diameter.....1. *A. glabrella* (p. 608)
1. Spores echinulate, verrucose, reticulate or alveolate..... 2
2. Spores definitely obovoid; fructifications viscid..... 3
2. Spores ellipsoid or ovoid..... 4
2. Spores spherical..... 13
3. Fructifications violet; spores finely asperate except the coarse verrucose surface of the distal end, 7.5-9.6 (-10) \times 5.5-7.4 μ2. *A. violacea* (p. 608)
3. Fructifications tawny; spores smooth to slightly asperate or verrucose, especially on the upper half, 11-15 \times 7.4-8.2 μ3. *A. nana* (p. 609)
4. Spores with a wrinkled utricle, or alveolate or reticulate..... 5
4. Spores merely rugose, verrucose, or echinulate..... 8
5. Spores alveolate, ellipsoid, dark brown, 10-12 \times 6-7.4 μ
-4. *A. ellipsoidea* (p. 610)
5. Spores citriform, with the utricle inconspicuously wrinkled longitudinally, 11-15 \times 8-11 μ ; peridium 1.5 mm. thick.....5. *A. ambigua* (p. 610)
5. Spores reticulate or reticulate-echinulate..... 6
6. Spores averaging more than 11 μ long, reticulate-echinulate, broadly ellipsoid, 10-13 \times 6-11 μ6. *A. Gardneri* (p. 611)
6. Spores averaging less than 11 μ long, reticulate..... 7
7. Peridium whitish, of fine hyphae, 100-300 μ thick; spores hyaline, broadly ellipsoid, areolate-reticulate, 8-11 \times 7.4-9 μ7. *A. Curtisii* (p. 612)
7. Peridium violet, of gelified hyphae, 100-115 μ thick; spores light brown, ellipsoid, obtusely pointed, pedicellate, shallowly and finely areolate-reticulate, 8-10 (-11) \times 4.4-5.6 (-7) μ8. *A. Campbellae* (p. 613)

9. Peridium more than 1 mm. thick; spores citriform, with slightly wrinkled utricles, $11-15 \times 8-11 \mu$5. *A. ambigua* (p. 610)
8. Spores more than 12μ long..... 9
8. Spores less than 12μ long..... 12
9. Peridium less than 0.6 mm. thick; spores broadly ellipsoid with round ends 10
10. Spores hyaline, echinulate, $14.5-15.5 \times 11-12 \mu$...9. *A. Stephensii* (p. 613)
10. Spores hyaline, reticulate-echinulate, $10-13 \times 6-11 \mu$
-6. *A. Gardneri* (p. 611)
10. Spores brown, verrucose, $11-20 \times 8-13 \mu$ 11
11. Peridium duplex, both layers of periclinal hyphae.....10. *A. africana* (p. 614)
11. Surface of peridium of periclinal hyphae.....11. *A. Behrii* (p. 615)
11. Surface of peridium of erect septate hyphae.....
-11a. *A. Behrii* var. *caudata* (p. 616)
11. Peridium duplex, outer layer prosenchymatous, $110-115 \mu$ thick, inner layers of slender periclinal hyphae.....12. *A. seminuda* (p. 617)
12. Spores alveolate, ellipsoid, dark brown, $10-12 \times 6-7.4 \mu$; peridium $170-350 \mu$ thick.....4. *A. ellipsoidea* (p. 610)
12. Spores verrucose, especially at distal end, ellipsoid, rounded above, brown, $7.5-9.6 (-10) \times 5.5-7.4 \mu$; peridium $60-100 \mu$ thick.....
-2. *A. violacea* (p. 608)
12. Spores completely verrucose, thick-walled, brown, $9.5-12.5 \mu$ long; peridium $150-500 \mu$ thick.....*Hydnangium purpureum* (p. 589)
12. Spores reticulate, broadly ellipsoid to subspherical, hyaline, $8-11 \times 7.4-9 \mu$; peridium $100-300 \mu$ thick.....7. *Arcangelicella Curtisii* (p. 612)
12. Spores reticulate-echinulate, broadly ellipsoid to subspherical, hyaline, $10-13 \times 6-11 \mu$; peridium $100-150 \mu$ thick.....6. *A. Gardneri* (p. 611)
13. Spores alveolate..... 14
13. Spores echinulate..... 16
13. Spores reticulate..... 27
14. Surface of peridium with layer of erect hyphae, giving plushiness to surface; spores minutely alveolate-echinulate, $10-12 \mu$ in diameter, yellowish.....13. *A. pilosa* (p. 619)
14. Surface without erect hyphae..... 15
15. Spores hyaline, alveolate-reticulate, $11-12.5 \mu$ in diameter (giants $12.5-15.5 \mu$); peridium of gelified interwoven hyphae.....15. *A. Ravenelii* (p. 622)
15. Spores yellow, alveolate-echinulate, $9-11 \mu$ in diameter; peridium prosenchymatous.....22. *A. cremea* (p. 628)
15. Spores brown, alveolate, and ragged, $12-15 \times 11-13 \mu$; peridium duplex, outer part of prosenchyma and inner of loosely interwoven hyphae.....
-12. *A. seminuda* (p. 617)
15. Spores very light yellowish, echinulate-reticulate, $8-15 \mu$ in diameter, (giants $16-19 \mu$); peridium of polyhedral-celled parenchyma covered by a fibrous layer of periclinal hyphae; gleba pinkish.....16. *A. socialis* (p. 623)
15. Spores dark yellowish, very finely and deeply alveolate-echinulate, $11-15 \mu$ in diameter; peridium of parenchyma with outer layer of compact prosenchyma; gleba cream-color.....17. *A. sciassilis* (p. 624)
16. Surface of the peridium with erect hyphae; spores $10-12 \mu$ in diameter.....
-13. *A. pilosa* (p. 619)
16. Surface without erect hyphae..... 17

17. Spores showing ridges or reticulations on the surface..... 18
17. Spores strictly echinulate (except short ridges in *A. vulvaria*)..... 21
 18. Spores less than 12 μ in diameter..... 19
 18. Spores more than 12 μ in diameter..... 20
19. Peridium 100–300 μ thick; spores 8–11 \times 7.4–9 μ 7. *A. Curtisii* (p. 612)
19. Peridium 55–80 μ thick; spores 7–9 (–11) μ in diameter.....
 -14. *A. alveolata* (p. 620)
 20. Spores hyaline, reticulate-alveolate.....15. *A. Ravenelii* (p. 622)
 20. Spores brown, alveolate.....12. *A. seminuda* (p. 617)
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1. *ARCANGELIELLA GLABRELLA* Zeller & Dodge, Ann. Mo. Bot. Gard. 22: 368. 1935.

Type: in Lloyd Mus., Dodge, and Zeller Herbaria.

Fructifications 1-1.5 cm. in diameter (drying 0.5-1.0 cm.), subglobose to depressed-globose, smooth, white to brownish, drying sordid white to buckthorn-brown; columella percurrent, of fibrillose tissue with lactiferous ducts and islands of hyaline, soft parenchyma; peridium about 640μ thick above to $80-130 \mu$ thick on the sides and below, of large-celled parenchyma with a surface or rind layer of compact, interwoven hyphae with lactiferous ducts; gleba white, drying ivory-yellow to cream-buff, cavities nearly spherical; septa thin, extremely scissile, of parallel hyphae with lactiferous ducts; in young specimens cylindrical cystidia (?), the dilated terminals of lactiferous ducts, breaking and exuding globules of latex; spores hyaline, smooth to slightly wrinkled above, pedicellate, subspherical, $4-6 \mu$ in diameter.

Australia and Tasmania. June to July.

The cystidia in this species are similar in size and shape to those reported by Setchell in *Arcangeliella alveolata* (*Elasmomyces russuloides*).

AUSTRALIA: Victoria, Lilydale, *F. Campbell* 27b (Broome Herb. at Brit. Mus.); *F. (Campbell) Martin* 467 (Kew).

TASMANIA: Kingston, Leslie Road, *L. Rodway* 1111 as *Gymnomyces pallidus*, type (Lloyd Mus., Dodge, and Zeller).

2. *ARCANGELIELLA VIOLACEA* (Masse & Rodway) Zeller & Dodge, Ann. Mo. Bot. Gard. 22: 369. 1935.

Hymenogaster violaceus Masse & Rodway, Kew Bull. Misc. Inf. 1898: 127. 1898; Saccardo & Sydow in Sacc. Syll. Fung. 16: 253. 1902; Rodway, Papers & Proc. Roy. Soc. Tasmania 1911: 29. 1912.

Type: in Kew Herb.

Fructifications spherical to irregular, 2-3 cm. in diameter; surface smooth, viscid, lilac-fusces then violet, drying orange-cinnamon, Mikado brown, or Saccardo's umber; sterile base small but distinct, with a usually percurrent columella,

with pseudoparenchymatous tissue; peridium 60–100 μ thick, composed of gelified pseudoparenchyma without and interwoven hyphae with lactiferous ducts within; gleba white then brown, drying Sayal brown; septa 36–45 μ thick, composed of hyaline hyphae with lactiferous ducts; basidia 11–16 \times 4 μ , cylindrical to clavate, sterigmata variable in length; spores obovoid, usually pedicellate, asperate with coarse warts above, 7.5–9.6 (–10) \times 5.5–7.4 μ .

Tasmania.

TASMANIA: Proctors Road, *L. Rodway 1262* (Dodge and Zeller); Cascades, Hobart, *L. Rodway 1106* (Lloyd Mus. 075, and Dodge); *L. Rodway 297*, type (Kew).

3. *ARCANGELIELLA NANA* (Masse & Rodway) Zeller & Dodge, *Ann. Mo. Bot. Gard.* 22: 368. 1935.

Hymenogaster nanus Masse & Rodway, *Kew Bull. Misc. Inf.* 1899: 180. 1899; Saccardo & Sydow in *Sacc. Syll. Fung.* 16: 256. 1902; Rodway, *Papers & Proc. Roy. Soc. Tasmania* 1911: 29. 1912; 1923: 153. 1924.

Type: in Kew Herb.

Fructifications 1.3 cm. high and broad, pyriform with a prominent sterile base, surface tawny-brown drying avellaneous to army-brown, smooth, viscid when moist; sterile base well developed, of prosenchyma with lactiferous ducts; peridium duplex, outer layer 180–200 μ thick, clear hyaline, of very gelified hyphae, inner layer 100–150 μ thick, dark brown, of collapsed stupose tissue, with large lactiferous ducts; gleba dark tawny-brown, drying russet-vinaceous, with a pallid yellowish, percurrent columella which dries pinkish-cinnamon; septa hyaline to brownish, of a loose prosenchyma, with a few lactiferous ducts, 35–40 μ thick; basidia 2–4-spored, 14–20 \times 6 μ ; spores narrowly obovoid, dark brown, smooth to slightly asperate, especially on the upper half, 11–15 \times 7.4–8.2 μ .

Tasmania and South Australia. August.

Rodway 1272 has much broader spores than the type of *A. nana* but seems identical in other characters.

TASMANIA: Hobart, *L. Rodway 609*, type (Kew and Lloyd Mus.); *L. Rodway 1272* (Dodge and Zeller).

AUSTRALIA: S. Australia, Encounter Bay, *J. B. Cleland 5* (Dodge).

4. *ARCANGELIELLA ELLIPSOIDEA* Zeller & Dodge, Ann. Mo. Bot. Gard. 22: 367. 1935.

Type: in Dodge and Zeller Herbaria.

Fructifications drying 0.7–3.0 cm. broad and 1–2 cm. high, depressed-subglobose, pyriform to reniform in vertical section, smooth, drying honey-yellow to isabella-color; sterile base prominent in young specimens, extended above into a percurrent (or nearly so) columella; peridium 170–350 μ thick, composed of a hyaline prosenchyma of large cells pierced by periclinal strands of hyphae including lactiferous ducts; gleba drying cinnamon-rufous to hazel, cavities relatively large; septa 30–65 μ thick, of fibrous prosenchyma, easily scissile; spores ovoid when young, ellipsoid at maturity, dark brown, finely alveolate, 10–12 \times 6–7.4 μ .

Since this collection was originally identified by Rodway as *Hymenogaster violaceus* (*Arcangeliella*) its colors when fresh doubtless are similar to that species.

TASMANIA: Hobart, L. Rodway 1286, as *Hymenogaster violaceus*, type (Dodge and Zeller).

5. *ARCANGELIELLA AMBIGUA* Zeller & Dodge, Ann. Mo. Bot. Gard. 22: 365. 1935.

Type: in Univ. Cal., Dodge, and Zeller Herbaria.

Fructifications pyriform to irregularly and variously lobed, up to 5 cm. broad and 3 cm. high, dirty white turning blue when touched, then wine-colored or black, drying honey-yellow to light brownish-olive, surface smooth to rimose and flaky due to splitting of a very thick peridium; sterile base prominent, stipitiform in some plants, drying corky, as well as other localized islands of sterile tissue; columella prominent and percurrent; peridium very thick, drying 1.5 mm. thick above, flaking off in patches and sometimes exposing the gleba below, composed of large, closely woven hyphae (4–7.5 μ in diameter) penetrated by numerous lactiferous ducts, and periclinal strands of prosenchyma of smaller hyphae which become the predominant type of tissue next to the gleba; gleba chocolate-color to wine-color when fresh, developing from the base upward, cavities small, sinuous, young parts just under the upper

peridium antique brown to auburn, older parts dry, blackish-brown; septa fragile, disintegrating in older specimens, of large, compactly interwoven hyphae penetrated by scattered lactiferous ducts, $35-45\ \mu$ thick; basidia $20-24 \times 6-8\ \mu$, clavate, 2- or 4-spored, sterigmata short, about $6-8\ \mu$ long, $1-2\ \mu$ in diameter; spores dark brown, ovoid to ovoid-citriform, sometimes with a broad apiculus, usually attenuated below to the breadth of the sterigma, with inconspicuous utricles, with 9-10 faintly visible longitudinal ribs; young spores $13-15 \times 8-9\ \mu$, mature spores $11-15 \times 8-11\ \mu$; odor of old leather.

Cespitose; partly immersed in hard soil under oak. California. May and June.

This large wine-colored species seems to be a transitional complex, partaking of the characters of various genera. Because of its sterile base, percurrent columella, and lactiferous ducts in all the sterile and tramal tissues, the species has been placed in *Arcangeliiella*. In sterile tissues it seems to have close affinities within the genus to *A. Beccari* and *A. vulvaria*, as well as *Phallobatia* and *Phallogaster*, but the spores are somewhat similar in shape to those of certain species of *Hymenogaster* and their ribbed surface somewhat like that in *Gautieria*.

CALIFORNIA: Santa Clara County, Saratoga, Dale Parks, type (Univ. Cal. as H. E. Parks 825, Z 31, also Dodge and Zeller 1810, 7820).

6. *ARCANGELIELLA GARDNERI* (Zeller & Dodge) Zeller & Dodge, Ann. Mo. Bot. Gard. 22: 367. 1935.

Gymnomyces Gardneri Zeller & Dodge, Ann. Mo. Bot. Gard. 6: 54-55. 1919.

Type: in Univ. Cal., Zeller, and Dodge Herbaria.

Fructifications subglobose to irregular, depressed, $2.5 \times 1.5 \times 1.5$ cm. in alcohol, drying $1.4 \times 0.8 \times 0.8$ cm., cream-color to yellow-ochre in alcohol, drying tawny-olive; peridium $100-150\ \mu$ thick, of homogeneous hyaline prosenchyma, except a narrow scissile layer of periclinal hyphae next to the gleba; columella dendroid, resembling much-thickened septa, of quite gelified, hyaline hyphae, with lactiferous ducts, drying russet-brown; gleba drying cream-color to clay-color, cavities small, globose

to irregular; septa hyaline, 60–80 μ broad, with lactiferous ducts; basidia hyaline, clavate 2-spored, 25–29 \times 9–10 μ , sterigmata slender, 6–7 μ long; spores subspherical, usually somewhat elongate, hyaline *sub lente*, 6–11 \times 10–13 μ , reticulate, rugose under oil immersion; latex white (Parks).

Under leaves of *Quercus agrifolia*. Pacific coast. December.

The locality in Texas must remain doubtful unless confirmed by further specimens, as the late C. G. Lloyd was sometimes careless in preserving original labels. George L. Fisher sometimes used a printed label with his address and may not have changed it to conform with each collection. Lloyd often recorded the address of a correspondent instead of the locality of collection.

TEXAS: Harris County, Houston, Geo. L. Fisher (Lloyd Mus. 65).

OREGON: Benton County, Corvallis, L. M. Booser 41 (Oregon State 3393, and Zeller 2208); H. P. Baras (Zeller 1728)

CALIFORNIA: no locality, H. E. Parks (Zeller); Parks 1130 (Dodge); Alameda County, Berkeley, N. L. Gardner, type (Univ. Cal. 376, Zeller 1618, and Dodge); Santa Clara County, H. E. Parks 913, Call of the Wild, H. E. Parks 943 A, Alder-croft, H. E. Parks 64, H. E. Parks & C. W. Dodge 1528, Guadalupe Mines, H. E. Parks Z11, Z348, Z429, 5 (1917), 273, 943b, and 3/4/21, H. E. Parks & Dale Parks 943, Saratoga, H. E. Parks 996 (all Univ. Cal., Dodge, and Zeller).

7. *ARCANGELIELLA CURTISII* Zeller & Dodge, Ann. Mo. Bot. Gard. 22: 367. 1935.

Hydnangium Ravenelii Farlow in Foerste, Bot. Gaz. 19: 37. 1894.—*non aliorum*.

Type: in Mo. Bot. Gard., and Curtis Herb. at Farlow.

Fructifications drying 0.7–1.4 cm. in diameter and isabella-color to brownish-olive; peridium 100–300 μ thick, soft, fibrillose, of very fine periclinal hyphae, with lactiferous ducts forming the core of quite definite hyphal strands; gleba drying pinkish-buff to cinnamon-buff; septa drying 30–40 μ thick, stupose, scissile; spores subspherical to broadly ellipsoidal, 8–11 \times 7.4–9 μ , roughly areolate-reticulate.

This species differs from *A. Ravenelii* and *A. Gardneri* in spore size, surface characters, and structure of the peridium.

SOUTH CAROLINA: Darlington County, Society Hill, M. A. Curtis, type (Mo. Bot. Gard. 5647, and Farlow).

GEORGIA: Bainbridge, E. Foerste (Farlow).

8. *ARCANGELIELLA CAMPBELLAE* Berkeley & Broome in Zeller & Dodge, Ann. Mo. Bot. Gard. 22: 366. 1935.

Hymenogaster Campbellii Berkeley & Broome, herb. nom.

Type: in N. Y. Bot. Gard. Herb., Lloyd Mus., and Kew Herb.

Fructifications subspherical, obovoid to much lobed, attenuated below, 1–2.5 cm. in diameter, cespitose, “violet color outside” [Miss Campbell], drying clay-color to tawny-olive, surface dull, even, glabrous; sterile base prominent, attenuate stalk-like below, extending as a cone into the gleba or as a percurrent or branched columella, white within, of a very spongy, open-meshed prosenchyma of hyaline hyphae; peridium 100–115 μ thick, of very even thickness, composed of gelified, hyaline, interwoven hyphae with lactiferous ducts, periclinal on the surface, diagonal in the outer third, loosely periclinal in the middle third, more slender and closely periclinal in the inner third; gleba ochraceous-tawny (dry), cavities radiating from sterile base; septa scissile, of hyaline prosenchyma, 14–22 μ thick; basidia not seen; spores ellipsoid, obtusely pointed, slightly pedicellate, shallowly and finely areolate-reticulate, light brown (sub lente), 8–10 (–11) \times 4.4–5.6 (–7) μ .

Australia. September.

Miss Campbell called this fungus a “Violet Puffball.”

AUSTRALIA: Victoria, Melbourne (Lilydale), *F. Campbell 27a* (Mrs. Martin 429) (Kew, Lloyd Mus. 0229, Dodge, and N. Y. Bot. Gard. marked “from Massee Herb.”); South Australia, Mt. Lofly, *J. B. Cleland 13, 14* (Dodge, and Zeller, det. as *Hymenogaster fulvus* Rodw. by Rodway); Adelaide, *J. B. Cleland 784* (Dodge and Zeller).

9. *ARCANGELIELLA STEPHENSII* (Berkeley & Broome) Zeller & Dodge in Dodge, Ann. Mo. Bot. Gard. 18: 463. 1931; E. Fischer in Engler & Prantl, Die Nat. Pflanzenfam. ed. 2, 7a: 32. 1933.

Hydnangium Stephensii Berkeley & Broome, Ann. & Mag. Nat. Hist. I. 13: 352. 1844; Quélet, Ench. Fung. 247. 1886; Patouillard, Bull. Soc. Myc. France 30: 348. 1914; Soehner, Zeitschr. f. Pilzk. 2: 153–156. 1923; E. Fischer, Geobot. Inst. Rübel in Zürich, Veröffentl. 3: 573–576. 1925.

Octaviania Stephensii Tulasne, Fung. Hypog. 78. 1851; Corda, Icones Fung. 6: 36. 1854; DeToni in Sacc. Syll. Fung. 7: 159. 1888; Lloyd, Myc. Notes 67: 1140. 1922.

Octavianina Stephensii O. Kuntze, Rev. Gen. Pl. 3²: 501. 1898.

Hydnangium galathejum Quélet, Ench. Fung. 247-248. 1886; Patouillard, Bull. Soc. Myc. France 26: 199-201. 1910.

Octaviania galatheja DeToni in Sacc. Syll. Fung. 7: 491. 1888.

Type: in Kew Herb., British Mus., and Paris.

Fructifications about 2 cm. in diameter, dark rufous drying liver-brown to russet or Hays brown, smooth, rooting base and columella with lactiferous ducts yielding a white milky juice which assumes a reddish tint on exposure to the air but disappears from the cut surface on drying; peridium drying 130-200 μ thick, composed of gelified, interwoven hyphae, the outer portion more compact, the inner portion filled with lactiferous ducts 6 μ in diameter; gleba white drying cream-color, finally cinnamon to cinnamon-buff; septa slightly lactiferous, composed of slender hyphae embedded in a gel; spores broadly ellipsoidal to subspherical, with few very fine spines and a thick epispore, 14.5-15.5 \times 11-12 μ .

H. galatheja was separated from *H. Stephensii* on its yellow color but it seems to be only a color variation, as microscopically neither Patouillard nor we have been able to separate it.

EXSICCATI: Rabenhorst, Fung. Eur. 1319.

GERMANY: Bayern, Kaufbeurn, *E. Soehner* 782 (Soehner and Dodge).

FRANCE: *L. Quélet* (Upsala); Doubs, Hérimoncourt *L. Quélet*, Aout 1892 (Paris); Besançon, *F. Bataille* (Dodge); Jura, Lépina, *N. Patouillard*, Oct. 1902, 1909 (Farlow); Abbeville, *L. Quélet* (Upsala); Seine, *G. Malençon*, 1928 (Dodge) (all French specimens sub *H. galathejum*).

ENGLAND: Leigh Wood, *C. E. Broome*, distributed in Rabenhorst, Fung. Eur. 1319 (Farlow); near Bristol, *C. E. Broome* (J. W. Bailey Herb. at Brown Univ.); Bristol, *C. E. Broome* (Curtis Herb. at Farlow); Clifton, *H. O. Stephens & C. E. Broome*, 6 Aug. 1843, type (Kew, Brit. Mus., and Paris).

10. *ARCANGELIELLA AFRICANA* (Lloyd) Zeller & Dodge, Ann. Mo. Bot. Gard. 22: 365. 1935.

Octaviania africana Lloyd, Myc. Notes 67: 1142. 1922.

Octaviania africana Verwoerd, S. Afr. Jour. Sci. 22: 164. 1925.

Illustrations: Lloyd, Myc. Notes 67: f. 2172.

Type: in Lloyd Mus. and in Stellenbosch Univ. Herb. 2097.

Fructifications spherical, 1–1.5 cm. in diameter, drying cinnamon-brown to Dresden brown; peridium hard, duplex, the outer layer 150–160 μ thick, composed of closely woven, slender, hyaline hyphae 1.5–2 μ in diameter, the inner layer 375–400 μ thick, composed of hyaline, more loosely woven, septate hyphae 3–4 μ in diameter, with lactiferous ducts, separable; gleba drying from ferruginous to snuff-brown; septa 15–30 μ thick, bent, clavate, 25–30 \times 7–8 μ , sterigmata 10–15 μ long, filiform; spores brown, ellipsoidal, alveolate, slightly foveolate under the alveolae, 15 \times 11 μ , giant spores 18.5 \times 15 μ .

South Africa.

SOUTH AFRICA: Knysna, A. V. Duthie 325, type (Lloyd Mus. 97, Dodge and Zeller).

11. *ARCANGELIELLA BEHRII* (Harkness) Zeller & Dodge, Ann. Mo. Bot. Gard. 22: 366. 1935.

Splanchnomyces Behrii Harkness, Bull. Cal. Acad. Sci. 1: 30. 1884.

Hymenogaster Behrii DeToni in Sacc. Syll. Fung. 7: 174. 1888; Harkness, Proc. Cal. Acad. Sci. Bot. III. 1: 249. 1899.

Type: cotype in Dudley Herb. at Leland Stanford Jr. Univ., in Farlow Herb., N. Y. Bot. Gard. Herb., Lloyd Mus., and Dodge Herb.

Fructifications depressed-globose, 1–4 cm. in diameter, irregularly lobed, pale yellowish drying honey-yellow to isabellacolor, or chestnut-brown to cinnamon-brown; sterile base prominent, pulviniform, cartilaginous; peridium covering the upper half of the fructification, smooth to pulverulent, 85–130 μ thick, very fragile and peeling badly in sectioning, yellowish, somewhat gelatinous, composed of coarse, yellow hyphae; gleba lemon-yellow, drying cinnamon-brown, cavities large, empty; septa 25–30 μ thick, yellow to brown, composed of coarse, gelified, nearly parallel hyphae; basidia cylindrical, projecting beyond the hymenium a short distance, mostly 4-spored, sterigmata 5–6 μ long; spores ellipsoid, ovoid, coarsely and evenly verrucose, with thick epispore, averaging 12 \times 8.5 μ , usually pedicellate, 11–14 \times 8–10 μ , giant spores 14.5–20 \times 11–13 μ ; odorless.

In humus, under *Quercus agrifolia* and *Heteromeles arbutifolia*. Oregon and California. December to March.

The collection by Johnston (219) has quite a few young spores which show a thick epispore, and the distal end almost umbilicate with a very fine, hyaline apiculus projecting from the depression. Very subject to attack by *Sepedonium*.

OREGON: Benton County, Corvallis, S. M. Zeller 8198 (Zeller).

CALIFORNIA: Marin County, H. E. Parks 113 (1918) (Univ. Cal.); Wildwood Glenn, Sausalito, H. W. Harkness, type (Stanford, Farlow, N. Y. Bot. Gard., Lloyd Mus., and Dodge); Alameda County, Berkeley, N. L. Gardner 178 (Univ. Cal., Dodge, and Zeller); Contra Costa County, Richwood Cañon, H. E. Parks 2015 (Dodge and Zeller); Santa Clara County, Call of the Wild, H. E. Parks 291, Guadalupe, H. E. Parks 28, 387, 433 (Z14), 951 (all Univ. Cal., Dodge, and Zeller); San Bernardino County, San Antonio Mts., I. M. Johnston 219 (Lloyd Mus. and Dodge).

11a. var. CAUDATA Zeller & Dodge, Ann. Mo. Bot. Gard. 22: 366. 1935.

Arcangeliiella caudata Zeller & Dodge, Ann. Mo. Bot. Gard. 6: 49-52. 1919.

Illustrations: Zeller & Dodge, Ann. Mo. Bot. Gard. 6: 51, f. 1.

Type: in Univ. Cal., Dodge, and Zeller Herb.

Fructifications 0.8-2 cm. in diameter, spherical with attenuate base, flattened or plane above, some quite pyriform, "varying from light brown to a dark yellowish brown or maroon except on a limited area on the under side next to the very short stipe which is almost white" [Gardner], mummy-brown to clove-brown above and clay-color to olive-brown below (in alcohol), surface velvety; peridium 200-300 μ thick above, very thin or wanting below, sepia under the microscope, composed of radial septate hyphae perpendicular to the surface, forming pseudoparenchymatous tissue having cells about $9-10 \times 11-13 \mu$, the septa of the hyphae becoming constricted and finally abjointing spherical to oblong oidia-like cells from the surface of the peridium; base sterile, composed of septate, hyaline hyphae $3-5 \mu$ in diameter, with lactiferous ducts $6-8 \mu$ broad, more numerous towards the attenuate point which leads to a heavy, branched rhizomorph; rhizomorphs pseudoparenchymatous, brown, supplied with numerous lactiferous ducts; columella

variable from inconspicuous to percurrent, extending to the peridium above, sometimes with lateral branches, concolorous and continuous with the base, the few lactiferous ducts smaller than in the base; gleba fleshy, white or yellowish, drying isabella-color to brownish-olive, exposed near the base in older specimens, cavities small and irregular, somewhat radiating from the base and columella; septa hyaline, consisting of loosely interwoven, hyaline hyphae, few lactiferous ducts, 50–65 μ broad; cystidia hyaline, large, clavate; paraphyses cylindrical, obtuse, hyaline, septate, 19–20 \times 4–5 μ ; basidia hyaline, slender, clavate, 2–4-spored, 24–26 \times 9–13 μ , sterigmata short, stout, 3–6 μ long; spores mostly ovoid to ellipsoid, verrucose-rugose, pedicellate, yellow-ochre to ochraceous-tawny, 12–14.5 \times 9–11.5 μ , one large vacuole, exospore thick.

In leaf mould of *Quercus*. Oregon and California. November.

OREGON: Benton County, Corvallis, S. M. Zeller 2005 (Zeller).

CALIFORNIA: Alameda County, Berkeley, N. L. Gardner 219, type (Univ. Cal., Dodge, and Zeller 1623).

12. *ARCANGELIELLA seminuda* (Masse & Rodway) Zeller & Dodge, comb. nov.

Gymnomyces seminudus Masse & Rodway, Kew Bull. Misc. Inf. 1898: 125. 1898; Saccardo & Sydow in Sacc. Syll. Fung. 16: 249–250. 1902; Zeller & Dodge, Ann. Mo. Bot. Gard. 6: 56. 1919.

Octaviania brunneola Harkness, Proc. Cal. Acad. Sci. Bot. III. 1: 251. 1899; Saccardo & Sydow in Sacc. Syll. Fung. 16: 248. 1902.

Arcangeliella brunneola Zeller & Dodge, Ann. Mo. Bot. Gard. 22: 366. 1935.

Hydnangium McAlpinei Rodway, Papers & Proc. Roy. Soc. Tasmania 1923: 159. 1924.

Octaviania microsporium Mattiolo, herb. nom.

Type: in Kew Herb. Cotype of *O. brunneola* Harkn. in Dudley Herb. at Leland Stanford Jr. Univ. Type of *Hydnangium McAlpinei* in Rodway Herb. at Tasmanian Museum.

Fructifications soft and watery, irregularly spherical, up to

5 cm. in diameter, whitish to muddy brown and ochraceous, drying isabelline, fawn, Natal brown to almost black, 1-2.0 cm. in diameter; sterile base present in young material, wanting at maturity; columella very slender, irregularly developed (arising in two separate places in one specimen) and easily overlooked, composed of closely parallel hyphae loosely interwoven or collapsing into a solid tissue; peridium 500-550 μ thick when fresh and in preserved material, drying 150-200 μ thick in the folds to even 50 μ thick in collapsed portions, outer layer separable, comprising most of the thickness (in the type of *G. seminudus* only half the thickness), composed of strands of more or less parallel hyphae 1.5-3 μ in diameter, very loosely woven, leaving large lacunae or collapsing on drying in the thinner portions and giving a prosenchymatous appearance, brownish, inner layer 35-40 μ thick, continuous with the septa and of the same structure, lactiferous ducts occasional throughout, more frequent in the outer portion of the peridium; gleba dense, dark olive-buff becoming avellaneous or army-brown to almost black from spores (warm buff in the type), cavities small, nearly filled with spores; septa 15-40 μ thick, of slender, interwoven hyphae with lacunae much smaller than those in the peridium except in the angles between the cavities, not otherwise scissile, subhymenium pseudoparenchymatous, lactiferous ducts few; basidia cylindrical, 18-23 \times 6-7.5 μ , soon collapsing; spores spherical or nearly so, very slightly attenuate toward the pedicel, dark brown to black, smooth at first with thick epispore which becomes deeply alveolate, easily tearing and appearing unevenly and bluntly echinulate, 12-15 \times 11-13 μ , with about 12 spines per great circle.

In duff under conifers, *Quercus* and *Aesculus*. Pacific coast of North America and Tasmania. January to June in North America (no dates accompanying the Tasmanian material).

It is with some hesitation that we have included all these specimens in the same species. Fundamentally the structure is the same but there is much variation in size, color, and peridial measurements, apparently depending in part on the maturity of the specimen and in part on its subsequent reaction to

processes of drying. The very loose character of the peridium as seen in preserved material allows for a variable amount of collapse on drying. The extremes when first encountered were recognized by us as distinct species, but with the accumulation of material intergrading forms have been seen, until in the present state of our knowledge we have failed to find clear distinctions. It is possible that further field work in Tasmania, Oregon, and California, with more careful relating of immature and mature specimens, may solve some of the problems raised in this group.

OREGON: Benton County, Corvallis, *H. P. Barss* (Zeller 8190); Yamhill County, McMinnville, *S. M. Zeller* 2166 (Dodge and Zeller).

CALIFORNIA: Humboldt County, Trinidad, *H. E. Parks* 4625 (Zeller); Marin County, Mt. Tamalpais, *H. W. Harkness*, cotype of *O. brunneola* (Stanford); Monterey County, Pacific Grove, *N. L. Gardner* (299) & *M. B. Nichols* (Univ. Cal. and Zeller); Santa Clara County, San José, *H. E. Parks* 960b, Guadalupe, *H. E. Parks* 264, 314, 341, 367, 394, 435, 520, 522, 530, 987, 1125, Alma, *H. E. Parks* 404, *H. E. Parks* & *C. W. Dodge* 1158, without locality, *H. E. Parks* 1126 (all Univ. Cal., Dodge, and Zeller).

TASMANIA: *L. Rodway* 124, type (Kew); Hobart, *L. Rodway* (Lloyd Mus. 072, and Dodge); Cascades, *L. Rodway* 1110 (Dodge); Tasman Peninsula, *L. Rodway* 1278 (Dodge); Mt. Nelson, *L. Rodway*, type of *Hydnangium McAlpinei* (Rodway).

13. *ARCANGELIELLA PILOSA* Zeller & Dodge, Ann. Mo. Bot. Gard. 22: 368. 1935.

Type: in Dodge and Zeller Herbaria.

Fructifications 3–4.5 cm. broad \times 1–4 cm. high, globose to depressed-pyriform, shrinking on drying, at first whitish becoming reddish-brown, drying citrine-drab, light brownish-olive, or olive, smooth, pilose; sterile base prominent, extended above into a branched or plate-like, percurrent columella of loosely interwoven hyphae; peridium 500–1000 μ thick when fresh, drying 240–320 μ thick, of a meshy prosenchyma with lactiferous ducts, gelified at maturity, hyaline, the surface layer of erect hyphae 30–40 μ long and 2–3.5 μ in diameter, producing a plushy surface (matting down in preserved material); gleba firm, gelified, buff, drying hard and cinnamon to Saccardo's umber, cavities small, empty but collapsing; septa 20–35 μ thick, of slender, loosely interwoven, gelified (?) hyphae interspersed by a few lactiferous ducts; basidia clavate, 4-spored;

spores hyaline (light yellowish *en masse*), subspherical, minutely alveolate-echinulate, 10–12 μ in diameter.

In humus soil under oaks. California. February to April.

CALIFORNIA: Santa Clara County, Guadalupe, *H. E. Parks*, 4th 2340 type, 524, 525 (Zeller and Dodge).

14. *ARCANGELIELLA ALVEOLATA* (Cooke & Massee) Zeller & Dodge, *Ann. Mo. Bot. Gard.* **22**: 365. 1935.

Octaviania alveolata Cooke & Massee, *Grevillea* **16**: 2. 1887; Saccardo, *Syll. Fung.* **9**: 280. 1891; Cooke, *Handbook Austral. Fungi*, 246. 1892; Rodway, *Papers & Proc. Roy. Soc. Tasmania* **1919**: 112. 1920; **1923**: 159. 1924.

?*Octaviania Stephensii* var. *nuda* Harkness, *Bull. Cal. Acad. Sci.* **1**. 258. 1885.

Octavianina alveolata O. Kuntze, *Rev. Gen. Pl.* **3**²: 501. 1898.

Gymnomyces pallidus Massee & Rodway, *Kew Bull. Misc. Inf.* **1898**: 125. 1898; Saccardo & Sydow in *Sacc. Syll. Fung.* **16**: 249. 1902; Rodway, *Papers & Proc. Roy. Soc. Tasmania* **1911**: 25. 1912; **1923**: 160. 1924; Zeller & Dodge, *Ann. Mo. Bot. Gard.* **6**: 55–56. 1919.—not Zeller, *Mycologia* **4**: 197–198. 1922.

Elasmomyces russuloides Setchell, *Jour. Myc.* **13**: 240–241. 1907; Saccardo & Trotter in *Sacc. Syll. Fung.* **2**: 467. 1912.

?*Gymnomyces solidus* Rodway, *Papers & Proc. Roy. Soc. Tasmania* **1920**: 157. 1921; **1923**: 161. 1924; Trotter in *Sacc. Syll. Fung.* **24**: 1328. 1928.

Hydnangium glabrum Rodway, *Papers & Proc. Roy. Soc. Tasmania* **1920**: 157. 1921; **1923**: 157–158. 1924; Trotter in *Sacc. Syll. Fung.* **24**: 1328. 1928.

Hydnangium Hinsbyi Rodway, *Papers & Proc. Roy. Soc. Tasmania* **1923**: 158. 1924.

Illustrations: Setchell, *Jour. Myc.* **13**: pl. 107.

Type: Cudgegong River, *Hamilton* 514, in Kew Herb. Type of *Gymnomyces pallidus*, Tasmania, *L. Rodway* 299, in Kew Herb. Type of *Hydnangium glabrum*, Tasmania, slopes of Mt. Wellington, *L. Rodway*, not seen. Material from Cascades, *L. Rodway* 1280 (stated by Rodway to be cotype) in Dodge and Zeller Herbaria. Type of *Elasmomyces russuloides*, Califor-

nia, Alameda County, Berkeley, *N. L. Gardner & W. A. Setchell*. A specimen so determined in Lloyd Mus. "Herb. Univ. California, Fungi of California 220, *Elasmomyces russuloides* Setchell under *Quercus agrifolia*, Berkeley, N. L. Gardner, Nov. 24, 1904," has been studied by us, and considered to be a portion of the type. Type of *Hydnangium Hinsbyi* from Hobart, *L. Rodway*, in Rodway Herb. at Tasmanian Museum.

Fructifications subspherical, drying 2 cm. in diameter, pinkish-cinnamon drying walnut-brown to Rood's brown; sterile base prominent and gelified, columella inconspicuous and not well developed; peridium thin, fragile, often flaking off, drying 55–80 μ thick (only about 40 μ in the type), composed of slender, periclinal, gelified hyphae; gleba pale red-brown to ochre, drying pinkish-buff; cavities large, subspherical, about 0.2 mm. in diameter; septa thin, 30–40 μ thick, composed of hyaline, periclinal, gelified hyphae with lactiferous ducts which end in large "gloeocystidia"; basidia early collapsing; spores spherical, girdled by ridges, subreticulate, finely and minutely asperate, 7–9 μ in diameter, giant spores 10–11 μ .

Pacific coast of North America, Chile, and Australia.

It is somewhat doubtful whether material from Mt. Wellington and the Cascades, Tasmania, which Rodway referred to *Octaviania alveolata*, is correctly determined, as Rodway states that fructifications were "pale ochre with a dark peridium, gleba dense, waxy, pale ochre becoming dark." This description suggests *Hydnangium compactum* Harkness, but we have seen no material.

OREGON: Linn County, *S. M. Zeller 2590*, near Peoria *S. M. Zeller 2586* (both Zeller).

CALIFORNIA: Marin County, *S. Rafael, H. E. Parks 2110* (Univ. Cal. and Dodge); Alameda County, Berkeley, *N. L. Gardner 245* (Lloyd Mus. and Dodge), *220* (type of *Elasmomyces russuloides*, Univ. Cal. and Dodge); San Mateo County, Redwood Park, *H. E. Parks 2187* (Univ. Cal. and Dodge); Santa Clara County, Saratoga, *H. E. Parks 358, 450, 907, 947, 990, 1127*; Alma, *H. E. Parks 56*, *N. L. Gardner 508*, *H. E. Parks, Guadalupe, H. E. Parks 358, 372, 477* (all Univ. Cal. and Dodge); Los Gatos, *H. E. Parks 477 (227)* (Zeller).

CHILE: Concepción (dry hill top), *E. Thaxter*, Nov. 1904 (Farlow).

AUSTRALIA: Cudgong R., *Hamilton 514*, type (Kew); New South Wales, Moona Plains, *without collector* (Kew); Victoria, *without collector 1092* (Kew);

Melbourne, (Lloyd Mus. 0216); *F. Campbell* 27b (Kew); South Australia, Belair, *J. B. Cleland* 1, Mt. Compass, *J. B. Cleland* 21, Mt. Lofty, *J. B. Cleland* (all Dodge).

TASMANIA: *L. Rodway* 1277, 299, type of *Gymnomyces pallidus* (Kew); Cascades, *L. Rodway* 1280, type of *G. glabra* (Dodge and Zeller); Sandfly, *L. Rodway* 1107 (Lloyd Mus. and Dodge); Hobart, *L. Rodway* (Lloyd Mus. 088, sub *H. australiense*, and Dodge), 1106 (Lloyd Mus. 075, 0219, as *Hymenogaster violaceus*, and Dodge); unnumbered specimen, type of *Hydnangium Hinsbyi* (Rodway).

15. *ARCANGELIELLA RAVENELII* (Berkeley & Curtis) Dodge, Ann. Mo. Bot. Gard. 18: 463. 1931.

Octaviania Stephensii var. *Ravenelii* Berkeley & Curtis in Tulasne, Fung. Hypog. xvii. 1851; Cooke, Grevillea 6: 133. 1873; DeToni in Sacc. Syll. Fung. 7: 159. 1888.

Hydnangium Stephensii var. *Ravenelii* Berkeley, Grevillea 2: 33. 1873.

Hydnangium Ravenelii Berkeley & Curtis in Curtis, Bot. North Carolina, 110. 1867; Lloyd, Myc. Notes 15: 152. 1903; 41: 569. 1916; Patouillard, Bull. Soc. Myc. France 26: 204. 1910.

Octaviania Ravenelii Lloyd, Myc. Notes 67: 1140. 1922.

Type: Ravenel Herb. at Brit. Mus., Berkeley Herb. at Kew, Curtis Herb. at Farlow Herb., and in Upsala.

Fructifications 2.5–4 cm. in diameter, subspherical to pyriform, drying light fawn; sterile base not prominent; columella slender, percurrent with lactiferous ducts which exude a white aromatic milk; peridium 100–180 μ thick, of gelified, interwoven hyphae with lactiferous ducts 7–8 μ in diameter; gleba white becoming cream-color; septa 11–15 μ thick, of slender hyphae in a gel, with lactiferous ducts; basidia clavate, protruding, 1–4-spored, 30–32 \times 13–15 μ , sterigmata very slender, 7–12 μ long; spores subspherical, alveolate-reticulate, 11–12.5 μ in diameter, giant spores from 1-spored basidia, 12.5–15 \times 15–15.5 μ .

Partially emergent under leaf mold. Southeastern United States and Oregon.

EXSICCATI: Ravenel, Fung. Carol. II: 71; Fung. Amer. 16; Ellis, N. Amer. Fung. 1211.

WITHOUT LOCALITY: (Lloyd Mus. 52).

SOUTH CAROLINA: Santee Canal, *H. W. Ravenel* 883, type (Brit. Mus., Farlow, Kew, and Upsala); Aiken, *H. W. Ravenel*, in Ellis, N. Amer. Fung. 1211.

GEORGIA: Augusta, *Berry Brown* (N. Y. State Mus. and Zeller 7255).

FLORIDA: *G. Clyde Fisher 12* (Lloyd Mus. 10620); Gainesville, *H. W. Ravenel*, Fung. Amer. 16.

ALABAMA: Auburn, *F. S. Earle* (Lloyd Mus. 0211, 5981, and Dodge); *A. H. Povah 7182, 9080* (in Lloyd Mus., Farlow, Dodge, and Zeller); Spring Hill, *A. S. Bertholet* (Lloyd Mus. 7128, 7182).

OREGON: Corvallis, *S. M. Zeller 2569, 2574* (Zeller).

16. *ARCANGELIELLA SOCIALIS* (Harkness) Zeller & Dodge, Ann. Mo. Bot. Gard. **22**: 369. 1935.

Octaviania socialis Harkness, Proc. Cal. Acad. Sci. Bot. III. 1: 252. 1899; Saccardo & Sydow in Sacc. Syll. Fung. **16**: 248. 1902.

Illustrations: Harkness, Proc. Cal. Acad. Sci. Bot. III. 1: pl. 42, f. 5.

Type: cotype in Dudley Herb. at Leland Stanford Jr. Univ.

Fructifications depressed-globose, 1-2 cm. in diameter, or cespitose and coalescing into irregular masses $2 \times 2.5 \times 4$ cm., surface smooth, cream-color to pinkish, drying clay-color to tawny-olive; sterile base distinct, stipitiform below, continued above as a slender percurrent columella of interwoven hyphae with lactiferous ducts interspersed with islands of pseudoparenchyma; peridium brownish, 220-380 μ , drying 50-75 μ thick, composed of polyhedral cells 4-5 μ in diameter, with very thin walls covered by a thin layer of periclinal hyphae with lactiferous ducts, easily separable; gleba rose-pink drying pinkish-buff (dark brown in alcohol), cavities of medium size and empty; septa 120 μ thick (drying about 75 μ), scissile, composed of large, thin-walled pseudoparenchyma, cells up to 20-25 μ in diameter; basidia clavate, hyaline, $20-30 \times 7-12$ μ , 4-spored, sterigmata 7-8 μ long; spores spherical, hyaline, epispore very finely and shallowly alveolate, 8-15 (-19) μ in diameter; odor strongly yeast-like.

Hypogeous under *Eucalyptus*, *Pasania densiflora*, etc. Oregon and California. Winter and spring.

Unfortunately the field notes with *Parks 966* were evidently based on some *Hymenogaster* collected at the same time. We have been unable to trace the notes made on this collection. Paris 513 is a small, solitary fructification.

OREGON: Benton County, Philomath, *H. M. Gálkey* (Zeller 8189).

CALIFORNIA: *H. E. Parks* 909 (Univ. Cal. and Dodge); Humboldt County, Trinidad, *H. E. Parks* (Univ. Cal. and Dodge); Marin County, San Rafael, *H. E. Parks* 1134, 2070, 2071, 2107, 3036 (Univ. Cal. and Dodge); San Mateo County, Belmont, *H. W. Harkness* 232, cotype (Stanford); Redwood Park, *H. E. Parks* 2180, 2186, 2216 (Univ. Cal., Dodge, and Zeller); Santa Clara County, Aldercroft Creek, *H. E. Parks*, 1167, *C. W. Dodge* 1526, *Alma*, *H. E. Parks* 162 (com. N. L. Gardner 545), Almaden Road, *H. E. Parks* 1132, Guadeloupe, *H. E. Parks* 529, 966, Guadeloupe Mines, *H. E. Parks* 253, 264, 367 (all Univ. Cal. and Dodge); San Jose, *H. E. Parks* 2271, 389 (Univ. Cal., Dodge, and Zeller); Saratoga, *H. E. Parks* 219, 449, 450, 456, 460, 979, 981, 1000, and 2-13-21 (Univ. Cal. and Dodge); Felton Big Trees, *H. E. Parks* 513 (Univ. Cal. and Dodge).

17. *ARCANGELIELLA SCISSILIS* Zeller & Dodge, Ann. Mo. Bot. Gard. 22: 369. 1935.

Type: in Dodge and Zeller Herbaria.

Fructifications irregular in shape, up to 3 cm. broad; surface very smooth, yellowish drying tawny; columella thin, white, reaching about halfway to the apex; peridium tough, easily cracking off when fresh, drying 320–400 μ thick, pseudoparenchyma with compact prosenchyma near the surface, and with lactiferous ducts; gleba creamy, drying antimony-yellow, compact; septa 25–35 μ thick, prosenchyma with lactiferous ducts; spores spherical, very finely and deeply alveolate-echinulate, dark yellowish, 11–15 μ ; strong odor of witch-hazel (*Hamamelis*).

Coniferous association. Northern California. November.

In this species the peridium is shell-like, easily cracking off, hence the name. The wood rats and pine squirrels eat the fructifications and seem especially fond of the peridium.

CALIFORNIA: Humboldt County, Trinidad, *H. E. Parks* 4125, type (Dodge and Zeller).

18. *ARCANGELIELLA TASMANICA* (Kalchbrenner) Zeller & Dodge, Ann. Mo. Bot. Gard. 22: 369. 1935.

Hydnangium tasmanicum Kalchbrenner in Masee, Grevillea 19: 95. 1891; Saccardo, Syll. Fung. 11: 172. 1895; Cooke, Handbook Austral. Fungi, 247. 1892; Rodway, Papers & Proc. Roy. Soc. Tasmania 1911: 24. 1912.

Octaviania tasmanica Lloyd, Myc. Notes 67: 1141–1142. 1922.

Gymnomyces flavus Rodway, Papers & Proc. Roy. Soc. Tasmania 1917: 110. 1918; 1923: 161. 1924; Sacc. Syll. Fung. 24: 1328. 1928.

Type: location unknown to us, not found in Kew nor in Berlin.

Fructifications 1–2 cm. in diameter, drying black; fibrils present, adnate, black, scanty; columella probably present (although the specimens available have all been sliced too thin); peridium 140–180 μ thick, composed of yellowish varicose, vesiculose hyphae, sometimes simulating pseudoparenchyma, 5 μ in diameter, with latex ducts in the outer portion of the peridium; gleba drying Brussels brown, mottled or marbled by the veins, cavities filled; septa dimorphous, the thicker septa plate-like walls, white, 60 μ thick, composed of hyaline, varicose, vesiculose hyphae, sometimes pseudoparenchymatous, occasionally with lactiferous ducts, the thinner or true septa 20–30 μ thick, yellowish, composed of slender, gelified hyphae; spores spherical, 9–14.5 μ in diameter, dark brown, echinate-tuberculate, with conical spines.

Tasmania.

This species is very similar to *A. asterosperma* in tissue structure, color, and color and markings of spores. It differs, however, in size of spores and the more numerous and smaller echinulae. The specimens examined of *Gymnomyces flavus* were young specimens of *A. tasmanica* in which the mature spores were identical with those of the latter.

TASMANIA: Hobart, L. Rodway 1279 (Dept. Agr. Victoria [Australia], Lloyd Mus. 090 under *Gymnomyces flavus* Rodw., and Dodge); Wedge Bay, L. Rodway 1276, cotype of *Gymnomyces flavus* Rodway (Dodge).

19. ARCANGELIELLA AUSTRALIENSIS (Berkeley & Broome) Dodge, Ann. Mo. Bot. Gard. 18: 463. 1931.

Hydnangium australiense Berkeley & Broome, Trans. Linn. Soc. London II. Bot. 2: 66. 1883; DeToni in Sacc. Syll. Fung. 7: 176. 1888; Massee, Kew Bull. Misc. Inf. 1898: 128. 1898; Rodway, Papers & Proc. Roy. Soc. Tasmania 1911: 25. 1912.

Octaviania australiensis Cooke, Handbook Austral. Fungi, 246. 1892; Rodway, Papers & Proc. Roy. Soc. Tasmania 1923: 157. 1924.

Hydnangium brisbanense Berkeley & Broome in Cooke, Handbook Austral. Fungi, 247. 1892.

Secotium sessile Massee & Rodway in Rodway, Papers & Proc. Roy. Soc. Tasmania 1911: 30. 1912.

Elasmomyces sessilis Rodway, Papers & Proc. Roy. Soc. Tasmania 1924: 8. 1925.

Types of both *Hydnangium australiense* and *H. brisbanense* were based on the same specimen, Brisbane, F. M. Bailey 188, in Kew Herb. and in British Museum. The type of *Secotium sessile* is Tasmania, L. Rodway 647, in Kew, Dodge Herb., and in Lloyd Mus. 0238.

Fructifications subspherical, 2–3 cm. in diameter, pure white drying apricot-buff; stipe short (absent in slice of type available for study), columella vanishing in the gleba; peridium about 100 μ thick, of very loosely woven, periclinal, hyaline hyphae, separable; gleba light buff, cavities large, empty; septa thin, scissile, 50–60 μ thick, of slender, gelified hyphae; basidia clavate, soon evanescent; spores spherical, hyaline, 7–8 μ in diameter.

QUEENSLAND: Brisbane, F. M. Bailey 188, type of *H. australiense* and of *H. brisbanense* (Kew and Brit. Mus.).

VICTORIA: F. Martin 467 pro parte (Kew); no collector (Lloyd Mus. 0240); E. Gippsland, E. French, Jan. 1889 (com. Mueller, Kew); Mallee, J. Dickson, 7–10–25 (Dept. Agr. Victoria).

SOUTH AUSTRALIA: Mt. Lofty, J. B. Cleland 10, 17 (Dodge and Zeller); S. Yucca, E. T. Turner (Lloyd Mus. 11153, Dodge, and Zeller).

TASMANIA: L. Rodway 1282 (Dodge and Lloyd Mus. 071); L. Rodway 647, type of *Secotium sessile* (Kew, Dodge, and Lloyd Mus. 0328).

NEW ZEALAND: Dunedin, Anderson's Bay, H. K. Dalrymple (Weir Herb. 30049).

20. *ARCANGELIELLA KRJUKOWENSIS* (Bucholtz) Zeller & Dodge, Ann. Mo. Bot. Gard. 22: 368. 1935.

Secotium (*Elasmomyces*) *krjukowense* Bucholtz, Hedwigia 40: 314–315. 1901; Материалы къ морфологии и систематикѣ подземныхъ грибовъ . . . Издвн. Естеств. Ист. Музея Графини Е. П. Шереметевой въ С. Михайловскомъ Московской губ. 1: 142–143. 1902; Ann. Mus. 1: 159. 1903.

Illustrations: Bucholtz, Ann. Mus. 1: pl. 5, f. 8–10; Материалы къ морфологии и систематикѣ подземныхъ грибовъ . . . Издвн. Естеств. Ист. Музея Графини Е. П. Шереметевой въ С. Михайловскомъ Московской губ. 1: pl. 3, f. 8–10.

Type: Bucholtz Herb. at Farlow, and Berlin.

Fructifications subglobose to irregular, about 3 cm. in diameter, surface smooth, pure white, drying warm buff to buckthorn-brown, lower surface showing groove where peridium reaches the stipe, exposing gleba at maturity; columella percurrent; peridium of interwoven hyphae, with many lactiferous ducts and some islands of pseudoparenchyma, 50–130 μ thick; gleba orange when fresh, drying clay-color to tawny-olive; septa 40–45 μ thick, hyaline, with lactiferous ducts composed of loosely interwoven hyphae and islands of pseudoparenchyma, as also in the columella; basidia 2–4-spored; spores 8–11.5 μ , spherical, citrine-yellow *sub lente*, with short, broadly conic echinulae, young spores sometimes appearing merely asperate.

Hypogeous; caespitose to single. Under *Populus*, *Betula*, and *Tilia*. U. S. S. R. June.

U. S. S. R. [Russia]: Moskva, Krjukovo, *F. Bucholtz*, type (Farlow and Berlin).

20a. var. *MICHAJLOWSKJANA* (Bucholtz) Zeller & Dodge, *Ann. Mo. Bot. Gard.* 22: 368. 1935.

Secotium (*Elastomyces*) *michailowskianum* Bucholtz, *Hedwigia* 40: 315. 1901; Материалы къ морфологiи и систематикѣ подземныхъ грибовъ . . . Издан. Естеств. Ист. Музея Графини Е. П. Шереметевой въ С. Михайловскомъ Московской губ. 1: 143–144. 1902; *Ann. Myc.* 1: 171. 1903.

Elastomyces michailowskjanus Saccardo & D. Saccardo in *Sacc. Syll. Fung.* 17: 218. 1905.

Illustrations: Bucholtz, *Ann. Myc.* 1: *pl. 5, f. 11*; Материалы къ морфологiи и систематикѣ подземныхъ грибовъ . . . Издан. Естеств. Ист. Музея Графини Е. П. Шереметевой въ С. Михайловскомъ Московской губ. 1: *pl. 3, f. 11*.

Type: probably in Bucholtz Herb. at Farlow Herb. but not seen.

Fructifications spherical, about 1 cm. in diameter, rufous; columella rather thick, of the same texture as *Arcangelietta krjukowensis*; gleba grayish-ochraceous; cystidia acute; spores and reactions as in that species.

While we have not seen the type of this species, there seems little to distinguish it from *A. krjukowensis*.

21. *ARCANGELIELLA BORZIANA* F. Cavara, Nuov. Giorn. Bot. Ital. N. S. 7: 126. 1900; Saccardo & Sydow in Sacc. Syll. Fung. 16: 256. 1902.

Illustrations: Cavara, Nuov. Giorn. Bot. Ital. N. S. 7: pl. 7, f. 1-15; Malençon, Trav. dédiés à Louis Mangin, pl. 29, f. 6.

Type: R. Ist. di Napoli, portion in Dodge and Zeller Herbaria.

Fructifications gregarious, spherical to irregular, oblong, often bilobed, $0.6-0.8 \times 1.5-3.0$ cm., smooth to pilose, somewhat soft, spotted with yellow; peridium very thin, $70-95 \mu$ thick, of closely interwoven hyphae, fragile, either lacking or lacerate near the base, slightly lactiferous, latex white, sweet, abundant; gleba light rose-colored, lactiferous; septa of interwoven hyphae, $5-75 \mu$ thick, base attenuate, sterile; cystidia conical, acute; basidia conspicuous, strongly exserted above the blunt paraphyses, sterigmata $3-4 \mu$ long, acicular; spores spherical to ellipsoidal, light yellowish, echinulate, $8-11 \mu$ in diameter, giants $12-13 \mu$, epispore thick.

In fir forests. Italy. Summer.

The specimen from France is referred here with some doubt as the peridium is lacking and lactiferous ducts are very rare.

ITALY: Trentino, *G. Bresadola*, Julio 1884 (probably Upsala); Etruria, Val-lombrosa, *F. Cavara*, type (R. Ist. di Napoli, Dodge, and Zeller); Lucca, *C. E. Broome* (Brit. Mus. sub. *H. asterospermum*).

FRANCE: Jura, *L. Quélet* (sub *Hydnangium candidum* in Cooke Herb. at Kew).

22. *ARCANGELIELLA CREMEA* Zeller & Dodge, Ann. Mo. Bot. Gard. 22: 367. 1935.

Type: in Dodge and Zeller Herbaria.

Fructifications very irregular in shape, drying subreniform, $1 \times 2 \times 2$ cm., light buff to cinnamon-buff, marbled; columella percurrent, creamy white; peridium variable, up to 250μ thick, of large, thin-walled, periclinal hyphae more or less prosenchymatous, with lactiferous ducts; sterile tissues a mixture of pseudoparenchyma and strands of prosenchyma with lactiferous ducts; gleba firm, cinnamon-buff; septa $120-130 \mu$ thick, pseudoparenchymatous except for a few large periclinal hyphae in the middle; basidia short-cylindric, $14 \times 8 \mu$, sterigmata slender, about 4μ long; spores spherical, yellow, $9-11 \mu$

in diameter, alveolate, having about 24 spines per great circle.
In duff under oak trees. Oregon. March.

OREGON: Benton County, Scott's Hill, south of Corvallis, E. Sprague, type (Zeller 7927, and Dodge).

23. *ARCANGELIELLA VULVARIA* (Petri) Zeller & Dodge, Ann. Mo. Bot. Gard. 22: 369. 1935.

Clathrogaster vulvarius Petri, Malpighia 14: 126. 1900; Saccardo & Sydow in Sacc. Syll. Fung. 16: 250. 1902.

Illustrations: Petri, Malpighia 14: pl. 2, f. 1, 2; pl. 3, f. 2, 3, 5-8, 10, 11, 13.

Type: in Herb. Bot. Ist. Univ. Firenze.

Fructifications irregular-reniform, about 4×6 cm., russet in alcohol (1934), surface irregularly reticulate-sulcate; sterile base scarcely more than a thickening of the peridium; columella conspicuous, fruticose, branching near the base but branches percurrent; peridium 1200-1440 μ thick in alcohol, composed of densely tangled hyphae without and loose periclinal hyphae within, gelified with abundant large lactiferous ducts 11-12 μ in diameter; gleba ochraceous-tawny, cavities ovoid, radiating from the columella; septa 110-120 μ thick, composed of loose, periclinal hyphae with large lactiferous ducts, not so completely gelified; basidia 2-spored, subcylindric, 37-40 μ long, the upper third collapsing after the separation of the spores, sterigmata short; spores spherical, with short ridges and slender, blunt spines, yellow, 9-12 μ in diameter.

Sarawak, Borneo, known only from the type collection.

BORNEO: Sarawak, near Sibü, O. Beccari, type (Univ. Firenze).

24. *ARCANGELIELLA OCCIDENTALIS* (Harkness) Zeller & Dodge, Ann. Mo. Bot. Gard. 22: 368. 1935.

Octaviania occidentalis Harkness, Proc. Cal. Acad. Sci. Bot. III. 1: 253. 1899; Saccardo & Sydow in Sacc. Syll. Fung. 16: 248. 1902.

Illustrations: Harkness, Proc. Cal. Acad. Sci. Bot. III. 1: pl. 42, f. 4.

Type: cotype in Dudley Herb. at Leland Stanford Jr. Univ.

Fructifications depressed-globose, 2-2.5 cm. in diameter, 1 cm. high, ochraceous-tawny to buckthorn-brown in alcohol;

stipe 0.4 cm. long, 0.3 cm. in diameter; columella percurrent, 0.1–0.15 cm. in diameter; peridium not enclosing the base, separating from the gleba, up to $360\ \mu$ thick, composed of interwoven, slender, gelified hyphae; gleba ochraceous-tawny to buckthorn-brown in alcohol, cavities empty, large, irregular; septa $120\text{--}150\ \mu$ thick, composed of loosely interwoven, gelified, slender hyphae, latex very scant; cystidia mucronate or flask-shaped, $36\text{--}40 \times 8\text{--}10\ \mu$; paraphyses truncate, clavate, septate; basidia $52 \times 5\text{--}6\ \mu$, clavate, sterigmata short; spores hyaline to slightly yellowish, $11\text{--}12\ \mu$ in diameter, spines acicular, short, numerous.

California, March.

CALIFORNIA: Placer County, Wire Bridge, *H. W. Harkness 137*, cotype (Stanford).

25. *ARCANGELIELLA ROSEA* (Harkness) Zeller & Dodge in Dodge, *Ann. Mo. Bot. Gard.* 18: 462. 1931.

Octaviania rosea Harkness, *Bull. Cal. Acad. Sci.* 1: 29. 1884; *Proc. Cal. Acad. Sci. Bot.* III. 1: 252. 1899; DeToni in Sacc. *Syll. Fung.* 7: 160. 1888.

Octavianina rosea O. Kuntze, *Rev. Gen. Pl.* 3²: 501. 1898.

Hydnangium Soderstroemii Lagerheim in Patouillard & Lagerheim, *Bull. Soc. Myc. France* 9: 142. 1893; Saccardo, *Syll. Fung.* 11: 172. 1895.

Arcangeliella Soderstroemii (Lagerh.) Zeller & Dodge, *Ann. Mo. Bot. Gard.* 6: 52. 1919.

Hydnangium pallidum Lloyd, *Myc. Notes* 65: 1031. 1921.

Octaviania pallida Lloyd, *Myc. Notes* 67: 1140. 1922.

Octaviania Stillingeri Lloyd, *Myc. Notes* 67: 1140. 1922; Rick, *Egatea* 14: 111. 1934.

Illustrations: Lloyd, *Myc. Notes* 65: *pl.* 171, *f.* 1867.

Type: cotypes in Dudley Herb. at Leland Stanford Jr. Univ., Lloyd Mus., Farlow, and Mo. Bot. Gard. Herbaria. Type of *H. Soderstroemii* in Stockholm, Upsala, Berlin, Patouillard Herb. at Farlow Herb., and Lloyd Mus. Type of *H. pallidum* in Lloyd Mus. and Dodge Herb. Type of *O. Stillingeri* in Lloyd Mus. and Dodge Herb.

Fructifications depressed-globose to pyriform, 2–3.5 cm. in

diameter, pinkish or pale rose when fresh, drying ashy or buckthorn-brown to isabella-color; sterile base attenuate, short or inconspicuous; columella rudimentary or percurrent, confluent with the peridium above, always very thin; peridium smooth and persistent above, evanescent below, early breaking away from the sterile base, 50–80 μ thick, of large-celled pseudoparenchyma with large superficial hyphae giving a silkiness to the surface; gleba pale, drying chamois to isabella-color or grayish, fragile, cavities relatively large, mostly radiating from the base and columella; septa thin, fragile, drying about 40 μ thick, of loosely woven, often gelified hyphae with lactiferous ducts; basidia mostly 2-spored, subcylindrical, 40–60 \times 6–10 μ ; sterigmata stout, conical, 6–10 μ long; spores subspherical, oblate below, pedicellate, rather finely echinulate (about 20 to the circumference), 11–17 μ in diameter, giant spores 17–19 μ , with coarser conical spines, thick epispore; latex white.

Mostly hypogeous in coniferous woods. Pacific Coast of United States and South America. Spring and autumn.

OREGON: Benton County, Corvallis, S. M. Zeller 2559 (Zeller).

CALIFORNIA: Alameda County, Berkeley, H. E. Parks 995, 1967, 1967a, 1967b (Dodge and Zeller); San Francisco, Golden Gate Park, H. W. Harkness 117, cotype (Stanford, Lloyd Mus., 0232, Mo. Bot. Gard. 5638, and Farlow), C. E. Stillinger, type of *O. Stillingeri* (Lloyd Mus., Dodge, and Zeller); Ingleside, N. L. Gardner 209 in part (Univ. Cal., Dodge, and Zeller); Parnassus Heights, Suto Woods, E. H. Kelley (com. N. L. Gardner 22, Univ. Cal., Dodge, and Zeller); W. A. Setchell & C. C. Dobie (com. N. L. Gardner 25, Univ. Cal.); Santa Clara County, Saratoga, H. E. Parks 1014, 2161, Guadalupe, H. E. Parks 393, San José, St. James Park, H. E. Parks 271, 276, (Z30), 389, 393, 397, Zeller 1666 (H. E. Parks) (all Univ. Cal., Dodge and Zeller).

ECUADOR: Quito, L. Söderström & Lagerheim, 1891, 1892, type of *H. Söderstroemi* (Stockholm, Upsala, Berlin, Farlow, Lloyd Mus. 6395, Dodge, and Zeller); L. Mille 3, type of *H. pallidum* (Lloyd Mus. 12127, Dodge, and Zeller).

BRAZIL: J. Rick 325 (Lloyd Mus., and Dodge).

26. *ARCANGELIELLA ASTEROSPERMA* (Vittadini) Zeller & Dodge, Ann. Mo. Bot. Gard. 22: 366. 1935.

Octaviania asterosperma Vittadini, Monogr. Tuberac. 17. 1831; Tulasne, Ann. Sci. Nat. Bot. II. 19: 276. 1843; Fung. Hypog. 77–78. 1851; Berkeley & Broome, Ann. & Mag. Nat. Hist. I. 18: 76. 1846; Corda, Icones Fung. 6: 35–36. 1854; Winter in Rabenhorst, Krypt.-Fl. Deutschl. 1: 878. 1883; De-

Toni in Sacc. Syll. Fung. 7: 159. 1888; Massee, Ann. Bot. 4: 31. 1889 [often cited as Monogr. Brit. Gast.]; Hesse, Hypog. Deutschl. 1: 72-74. 1891; Boudier, Icones Myc. 4: 97-98. 1905-1910; Hollós, Magyar. Földalatti Gombai, 95-96, 206-207. 1911; Patouillard, Bull. Soc. Myc. France 30: 347-348. 1914; Lloyd, Myc. Notes 67: 1143. 1922 (pro parte).

Hydnangium asterospora Quélet, Mém. Soc. d'Émulation de Montbéliard 4: 368. 1873 [often cited as Champ. du Jura et des Vosges 2]; Ench. Fung. 248. 1886.

Octaviania mutabilis Roumeguère, Rev. Myc. 7: 23. 1885; DeToni in Sacc. Syll. Fung. 7: 159-160. 1888; Bucholtz, Bull. Soc. Imp. Nat. Moscou N. S. 21: 485-486. 1908.

Octaviania brunnea Hesse, Hypog. Deutschl. 1: 78-79. 1891; Sacc. Syll. Fung. 11: 169. 1895.

Octavianina asterosperma O. Kuntze, Rev. Gen. Pl. 3²: 501. 1898.

Octavianina brunnea O. Kuntze, Rev. Gen. Pl. 3²: 501. 1898.

Octavianina mutabilis O. Kuntze, Rev. Gen. Pl. 3²: 501. 1898.
—*not Octaviania mutabilis* Hesse, Hypog. Deutschl. 1: 77. 1891.

Octaviania asterospora Th. M. Fries, Svensk Bot. Tidskr. 3: 272-273. 1909; Th. C. E. Fries, Ark. f. Bot. 17^o: 12. 1922.

Illustrations: Baillon, Dict. 1: 745, f. 4; Boudier, Icones Myc. 1: pl. 191; Cooke, Handbook Brit. Fung. 1: 355; Corda, Anleit. z. Stud. Myc. pl. D, f. 45: 5-6; Fourquignon, Champ. Supér. 123, f. 94; Hesse, Hypog. Deutschl. 1: pl. 3, f. 1-7; pl. 5, f. 15; pl. 6, f. 4; Luerssen, Syst. d. Bot. 262, f. A; Payer, Bot. Crypt. 114, f. 529; Quélet, Mém. Soc. d'Émulation de Montbéliard 4: pl. 4, f. 3 [often cited as Champ. du Jura et des Vosges 2]; Roumeguère, Cryptog. Illustr. f. 374; Smith, Brit. Basid. 487, f. 140; Swanton, Fungi, pl. 17, f. 9-11; Tulasne, Ann. Sci. Nat. Bot. II. 19: pl. 17, f. 21; Fung. Hypog. pl. 11, f. 1; Vittadini, Monogr. Tuberac. pl. 3, f. 7; pl. 5, f. 9a; Winter in Rabenhorst, Krypt-Fl. Deutschl. ed. 2, 1: 871.

Type: Material from Vittadini in Brit. Mus. and in Paris. Type of *O. mutabilis* distributed in Roumeguère, Fung. Sel. Gall. Exsicc. 3159, a copy in Farlow Herb., also cotype ex herb. Bommer in Lloyd Mus. Type of *O. brunnea* in Upsala.

Fructifications subspherical to reniform, up to 5×3.5 cm.; surface tubercular-verrucose, pulverulent, with numerous fibrils, pure white with pinkish flecks which disappear, becoming greenish passing to deep olive, dirty brown to the touch, avellaneous or warm sepia to wood-brown or bister in alcohol, drying cinnamon-buff to sepia or even black; sterile base pulvinate to palmate in vertical section, prosenchymatous with hyaline lactiferous ducts, on drying prosenchyma partially collapsing; peridium $320\text{--}480\ \mu$ thick, drying $150\text{--}200\ \mu$, hyphae with vesiculose cells on the outside, within prosenchyma of large, vesiculose cells and relatively few lactiferous ducts; gleba white, exuding a salmon-tinted milk, brownish turning blue-black on exposure, becoming warm sepia in alcohol, and drying cinnamon-brown to Prout's brown or snuff-brown; cavities comparatively large, more or less radially arranged, filled with spores; septa hyaline, prosenchymatous, of large, vesiculose cells often appearing pseudoparenchymatous, with lactiferous ducts, the larger, plate-like septa $110\text{--}150\ \mu$ (drying $75\text{--}100\ \mu$) thick, the smaller septa $30\text{--}35\ \mu$ (drying $20\text{--}25\ \mu$) thick; basidia short, clavate, $20\text{--}22\ \mu$ long, 4-spored, sterigmata $5\text{--}6\ \mu$ long; cystidia fusiform, $50\text{--}60 \times 13\text{--}14\ \mu$; spores spherical, thickly covered with large conical to pyramidal spines $2\ \mu$ long, $13\text{--}16\ \mu$ in diameter including the spines, warm sepia; odor of acrid meal; latex salmon-color.

Europe and eastern North America.

The texture, the dark color of the spores, and the spore-filled cavities apparently led Vittadini to include this species in his genus *Octaviania* (*Melanogaster* Corda) where it was sharply distinguished from the other species of the genus by its star-shaped spores.

EXSICCATI: Roumeguère, Fung. Sel. Gall. 3159; Rabenhorst, Fung. Eur. 1277.

SWEDEN: Stockholm, L. Romell, 1912 (Upsala).

DENMARK: Munkebjerg, H. Jensen, 1888 (Upsala); Moen, Lisslund, F. Rosenkrantz, 25 Aug. 1900 (Upsala).

CZECHOSLOVAKIA: Boehmerwald, Arber, 200 m., Soehner 773 (Soehner and Dodge).

GERMANY: Marburg, R. Hesse, 1886, 1 July, 1890, type of *O. brunnea*, Aug. 19, 1891, 1901 (Upsala); Altmorsehen, R. Hesse, 29 March, 1900; also Altmorsehen, R. Hesse, sub. *O. brunnea* (both Farlow).

ITALY: Lombardia, near Milano, *C. Vittadini*, type (Brit. Mus., Paris); Lucca, *C. E. Broome*, Sept. 1846, and spec. no date (Brit. Mus.).

ALGERIA: Oran, *without collector* (Kew).

FRANCE: Ardennes, Florenville, *E. Bommer & M. Rousseau*, type of *O. mutabilis* in Roumeguère, Fung. Sel. Gall. Exsicc. 3159 (Farlow, also specimen ex herb. Bommer in Lloyd Mus. and Dodge); Seine-et-Oise, Montmorency, *E. Boudier* (Lloyd Mus. 5339, and Dodge); Loiret, Gien, *Tulasne*, 1843 (Paris); Loire-et-Cher, Mer, *N. Patouillard* (Farlow); Jura, Lépiniay, *N. Patouillard*, Aug. 1913 (Farlow); *L. Quélet* (Upsala); Vandoucourt, *L. Quélet* (Upsala).

ENGLAND: Cornwall, Boconnoc, near Lostwithiel, *C. E. Broome*, Oct. 1848, Oct. 1849 (Brit. Mus.); Devonshire near Chudleigh, Oct. 1845, *C. E. Broome* (Brit. Mus.); *C. E. Broome* (Farlow); ex herb. J. Ralfs (Brit. Mus.); Wiltshire, Bowood, *C. E. Broome*, Oct. 1863 (Brit. Mus., Kew, and Upsala); Hampshire, Lyndhurst, *C. E. Broome*, (Brit. Mus. and Kew).

NEW YORK: Michigan Hollow, near Ithaca, *H. M. Fitzpatrick* 9969, 25 Sept., 1926 (Dodge and Zeller 1543).

MICHIGAN: Ann Arbor, *C. H. Kauffman*, 2 Oct. 1892, *B. B. Kanouse* (both Univ. Mich., Dodge, and Zeller).

NORTH CAROLINA: Cranberry, *E. Thaxter B2H* (Farlow).

TENNESSEE: Burbank, *E. Thaxter B2, H 1* (Farlow).

26a. var. *DEPAUPERATA* (Tulasne) Zeller & Dodge, Ann. Mo. Bot. Gard. 22: 366. 1935.

Octaviania asterosperma var. *depauperata* Tulasne, Fung. Hypog. 78. 1851.

Octaviania vacua Tulasne, herb. nom.

Illustrations: Tulasne, Fung. Hypog. pl. 11, f. 2.

Type: Tulasne Herb. at Paris.

This variety differs from the species in having almost no sterile base, basidia linear, obtuse, spores subobovate, appearing transversely striate, rugulose and appendiculate.

Under fallen leaves of *Quercus suber*. Southern France. December to January.

Gymnomyces vesiculosus Coker & Couch, Gast. E. United States & Canada, 23. pl. 16, 17, 105. 1928, may belong here but no material has been seen.

FRANCE: Var, Hyères, *Tulasne*, Dec. 1844, type (Paris).

26b. var. *HOLELEUCA* (Hesse) Zeller & Dodge, Ann. Mo. Bot. Gard. 22: 366. 1935.

Octaviania asterosperma var. *hololeuca* Hesse, Hypog. Deutschl. 1: 74. 1891.

Type: location unknown to us, but specimens labeled *Oc-*

taviana asterosperma var. from Marburg, collected and determined by R. Hesse, at Farlow Herb. and at Upsala, agree with Hesse's description in having very small cavities and a thick, silky, white peridium.

Fructifications large, $3-4 \times 2-2.5$ cm., depressed-globose to reniform; surface felty-fibrillose, light buff to Prout's brown (in alcohol) to Mars brown where touched; peridium 900–1500 μ thick, stupose, of loosely woven, brownish hyphae, about 3 μ in diameter, consistency of felt; sterile base prominent, of large white hyphae, up to 8 μ in diameter; gleba clay-colored to tawny-olive in younger specimens to hazel and Prout's brown in larger specimens, veins large, white; cavities rather large, becoming filled with spores; septa thick, 85–140 μ thick (80–100 μ not including hymenia), of hyaline, stupose, interwoven hyphae about 3 μ in diameter; basidia 2–4-spored, $19-22 \times 8$ μ ; spores 11–14 μ in diameter (15–18 μ with echinulae), appendiculate, dark brown, warted with large echinulae, about 8–12 to the periphery.

GERMANY: Marburg, R. Hesse, type (Farlow, under the name *Octaviana asterosperma* Vitt. var.).

27. ARCANGELIELLA BECCARI (Petri) Zeller & Dodge, Ann. Mo. Bot. Gard. 22: 366. 1935.

Clathrogaster Beccari Petri, Malpighia 14: 126. 1900; Sacc. & Sydow in Sacc. Syll. Fung. 16: 250. 1902.

Illustrations: Petri, Malpighia 14: pl. 2, f. 3–5, 7–9.

Type: in Bot. Ist. Univ. Firenze and Dodge Herb.

Fructifications spherical to reniform, 1–3 cm. in diameter, raw sienna in alcohol [1934], surface smooth; no sterile base nor columella evident; peridium about 640 μ thick in alcohol, composed of densely tangled hyphae without, and loose periclinal hyphae within, embedded in a gel with lactiferous ducts 7–8 μ in diameter, relatively straight; gleba amber-brown, cavities elongate, radiating from the base which is scarcely more than a thickened peridium; septa about 110 μ thick, the inner 30–40 μ thick, similar to the inner peridium in structure; basidia clavate, 2-spored, about 80×11 μ , only the outer half collapsing after the separation of the spore, sterigmata short;

spores 11–15 μ in diameter, spherical with very high ridges, irregularly disposed over the surface, yellow.

Sarawak, Borneo, known only from the type locality.

This species is closest to *A. Gardneri* in spore markings but differs in the spherical spores, thicker peridium, much larger basidia and spores.

BORNEO: Sarawak, Sibü, O. Beccari, type (Dodge and Univ. Firenze).

MACOWANITES

Macowanites Kalchbrenner, Grevillea 10: 107. 1882; DeToni in Sacc. Syll. Fung. 7: 179. 1888; E. Fischer in Engler & Prantl, Die Nat. Pflanzenfam. I. 1^{**}: 200–300. 1899; Zeller & Dodge, Ann. Mo. Bot. Gard. 6: 56–59. 1919.

Macowania Kalchbrenner, Gardeners' Chron. N. S. 5: 785. 1876.—*non Macowania* Oliver in Hooker, Icon. Pl. III. 1: 49. 1870.

The type species of the genus is *Macowanites agaricinus* Kalchbrenner.

Fructifications subspherical when young, pileate at maturity, epigeous, stipitate, fleshy; peridium covering the top of the pileus only; gleba covering the under surface of the pileus, free to decurrent, composed of irregular anastomosing cavities, more or less radiating from the stipe; basidia 2-spored; spores spherical, echinulate.

1. *MACOWANITES AGARICINUS* Kalchbrenner, Grevillea 10: 107. 1882; DeToni in Sacc. Syll. Fung. 7: 179. 1888; Lloyd, Myc. Notes 7: 1198. 1923; Zeller & Dodge, Ann. Mo. Bot. Gard. 6: 58–59. 1919; Verwoerd, S. Afr. Jour. Sci. 22: 166. 1925.

Macowania agaricina Kalchbrenner in Gardeners' Chron. N. S. 5: 785. 1876.

Illustrations: Kalchbrenner, Gardeners' Chron. N. S. 5: 785, f. 141; E. Fischer in Engler & Prantl, Die Nat. Pflanzenfam. I. 1^{**}: f. 148; Lloyd, Myc. Notes 7: pl. 245, f. 2455, 2456.

Type: South Africa, *MacOwan* 1211, a slice lacking one corner (which is in N. Y. Bot. Gard.) at Kew, a slice in Upsala; two water-color drawings (reproduced in the 'Gardeners' Chronicle') at Kew, showing pileus buffy brown, gleba isabella, stipe

white with cut surface cartridge-buff or a little darker below. These drawings seem to have been based on another specimen, perhaps the one in Upsala, which is much less expanded.

Fructifications hemispheric when young becoming deep infundibuliform, resembling *Cantharellus floccosus* in habit (judging from the dried slice), pileus drying Sayal brown, flesh thick about the depression, abruptly thinning beyond the disc; peridium continuous over the top of the pileus, about $30\ \mu$ thick, of compact, thick-walled, periclinal hyphae, flesh of large, loosely woven, thin-walled hyphae with lactiferous ducts; stipes short, merging into the flesh of the pileus, sometimes resembling the tissues in the stipe of *Lycoperdon*, drying Sayal brown; gleba decurrent, deep olive-buff with snuff-brown septa, cavities contorted, empty, open below; septa variable in thickness, similar to the flesh in texture; basidia clavate, 2-4-spored, soon collapsing; spores ellipsoidal to subspherical, echinulate, asymmetrically placed on the sterigma as in the Hymenomyces, $11-12\ \mu$ in diameter.

Known only from the type collection.

SOUTH AFRICA: Somerset East, MacOwan 1211, type (Kew and Upsala).

2. *MACOWANITES MAGNUS* Parks in Zeller & Dodge, Ann. Mo. Bot. Gard. 22: 369. 1935.

Type: in Univ. Cal. Herb.

Fructifications 3-14 cm. broad, resembling a stout agaric or *Boletus*, cap irregular, at first conic then expanded and almost plane, margins irregular to sinuate, surface smooth, viscid, pale tan to dark brown when fresh, drying fawn-brown to army-brown or cinnamon-buff; stipe short, thick, central, up to 3 cm. thick, 3-7 cm. long, white, brittle, hollow-stuffed, bulbous at base, abruptly attenuated below bulb, subglabrous to innate-fibrillose, homogeneous inside, of longitudinal, meshy fibrillae of fine hyphae; gleba white at first, drying warm buff with vinaceous tints, spongy as in *Gautieria morchelliformis*, expanded, more or less radiating from the center of the pileus, free to adnexed, exposed below, covered by a peridium above, cavities large, labyrinthiform; peridium duplex, about $250-380\ \mu$ thick, inner layer $150-250\ \mu$ thick, loosely stupose with ropy strands

of fine hyphae, outer layer 70–120 μ thick, compact, stupose, of gelified hyphae, viscid; septa averaging 170 μ thick including hymenia (about 95 μ between hymenia), stupose in central portion, subhymenia pseudoparenchymatous; basidia large, cylindric to subclavate, 2-spored, projecting above paraphyses, 10–11 \times 20–24 μ ; paraphyses cylindric, 4–6 \times 30–50 μ ; sterigmata short; spores subspherical, spines short, fine, 7.5–10 μ in diameter, hyaline; odor and taste like a mild *Lactarius*, becoming pungent and offensive in age.

Partially covered by leaves, under various kinds of trees. Oregon and California. October and November, and May.

Because of the lactiferous ducts in the sterile tissues this species may be considered close to *Arcangeliella*.

In the Oregon collections the surface is even, shiny-glabrous, interspersed with tiny squamules, avellaneous; gleba cream color; stipe white to cream-color, squamulose above.

OREGON: Lincoln County, near Agate Beach Inn, S. M. Zeller & A. H. Smith (Zeller 8235); Yachats, S. M. Zeller 8239 (Zeller).

CALIFORNIA: Santa Clara County, Call of the Wild, H. E. Parks 208, type (Univ. Cal., Dodge, and Zeller 2804).

MELANOASTER¹

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Owing to pressure of other work, there seems little opportunity for further study of the Hymenogasteraceae (*sensu latiore*) in the near future; consequently it seems well to present *Melanogaster* at this time without the small related genera of which we have seen little or no material. While the common European species are well represented in the larger herbaria, there are several species of doubtful affinity of which the types have been lost and which are known to us only from the original descriptions. We have included these, however, in the hope that they may be again encountered.

As in previous papers, we have used the same color standards and cited the specimens studied with the same abbreviations. For financial assistance we are grateful to the American Association for the Advancement of Science (grant in 1923 to the senior author), to the John Simon Guggenheim Memorial Foundation which appointed the junior author a fellow to Europe in the autumn in 1930, and to the Science Research Fund of Washington University (grant of 1933 to the junior author).

MELANOASTER

Melanogaster Corda in Sturm, Deutschl. Fl. III. 19: 1. 1831; Icones Fung. 5: 23. 1842.

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Bullardia Junghuhn, *Linnaea* 5: 408. 1830.—non *Bulliarda* Necker, *Elem.* 2: 321. 1790; DC. *Bull. Soc. Philomath.* 3: 1. 1801.

Octaviana Vittadini, *Monogr. Tuberac.* 15–20. 1831.

Argyllum Wallroth, *Fl. Cryptog. Germ.* 2: 874. 1833.

Hymenogaster Endlicher, *Gen. Pl.* 30. 1836.—non *al.*

?*Uperhiza* Bosc, *Ges. Naturf. Freunde Berlin Mag.* 5: 88. 1811 (without species name); Nees, *Syst. d. Pilze* 1: 159; 2: 41, *pl.* 15, *f.* 146. 1816 (as *U. carolinensis*).

?*Uperrhiza* Fries, *Syst. Orb. Veg.* 1: 135. 1825.

?*Hyperrhiza* Sprengel in Linné, *Syst. Veg.* ed. 16, 4: 416. 1827.

The type of *Melanogaster* is *M. tuberiformis* Corda. *Bullardia* was based on *B. inquinans* Jungh., usually considered a synonym of *M. variegatus* (Vitt.) Tul. *Bullardia* has universally been considered a variant spelling of *Bulliarda* and hence preoccupied. We have not seen type material, and prefer to regard it as a permanent source error. We have not recognized the specific epithet, *B. inquinans*, following the universal practice of the last century. *Octaviana* was based on *Octaviana variegata* Vitt. *Argyllum* Wallr. is based on *Bullardia inquinans* Jungh. *Uperhiza* and its variant spellings are all based on *U. carolinensis* Nees. This genus name was frequently used up to 1844 as a synonym of *Melanogaster* and of course antedates it. A careful reading of the Bosc and the Nees descriptions suggests that this is rather a species of *Scleroderma* but it is too poorly described to place in the absence of type specimens which have evidently been lost for at least a century. It seems unwise to overturn the nomenclature of the greater part of a century when, in the absence of adequate description or type, it may become a permanent source of confusion. We hereby recommend that *Melanogaster* be conserved against *Uperhiza* and its variant spellings, *Uperrhiza*, and *Hyperrhiza*.

Fructifications subspherical to irregular, usually brownish to blackish, at least at maturity, surface even, dull, usually with strong odors; fibrils usually present, often inconspicuous; peridium mostly prosenchymatous, sometimes with vesiculose cells, often not well differentiated from the septa of the gleba,

not separable; gleba usually dark brown becoming black in age with tendency to deliquesce, with whitish septa which may become discolored yellowish or reddish on wounding or in age, cavities filled by a gel containing the evanescent basidia and the spores; septa of gelified prosenchyma, often with traces of the fundamental tissue; basidia mostly clavate, evanescent, scattered throughout the gel of the cavities, borne singly on branching hyphae, 4-8-spored, sterigmata short and often very broad, so that the spores appear sessile on the basidium; spores brown, occasionally yellow, variable in shape from subspherical to subcylindric, usually with a thick episporium.

Confined to the more humid portions of the north temperate zone, except for one species from the mountains of Northern India and one species in New Zealand.

KEY TO THE SPECIES OF MELANOASTER

1. Spores averaging more than $11\ \mu$ in length..... 2
1. Spores averaging less than $11\ \mu$ in length..... 5
2. Spores citriform to almost fusiform, sometimes bluntly apiculate.....
 -1. *M. ambiguus* (p. 642)
2. Spores obovoid..... 3
3. Spores large, $15-18\ \mu$ long.....2. *M. macrosporus* (p. 644)
3. Spores smaller..... 4
4. Spores $11-13 \times 7.4-8\ \mu$3. *M. intermedius* (p. 645)
4. Spores $10-11.5 \times 5.5-7\ \mu$4. *M. tuberiformis* (p. 645)
5. Spores $10-11\ \mu$ long..... 6
5. Spores shorter..... 7
6. Spores more than $7\ \mu$ broad.....1a. *M. ambiguus* var. *eurypermus* (p. 643)
6. Spores $5.5-7\ \mu$ broad.....4. *M. tuberiformis* (p. 645)
7. Spores small, less than $5\ \mu$ long.....5. *M. microsporus* (p. 646)
7. Spores longer..... 8
8. Spores oblong to cylindrical..... 9
8. Spores ellipsoid, ovoid, or subspheroid..... 10
9. Spores definitely truncate below, $6-8.4 \times 3.5-4\ \mu$, rather dark *sub lente*....
 -6. *M. Broomeianus* (p. 647)
9. Spores rounded at both ends, $8-9.6 \times 5.5-6.5\ \mu$, almost hyaline *sub lente*..
 -7. *M. rubescens* (p. 648)
10. Gleba drying brown or brownish-black, spores rather dilute brown or yellowish..... 11
10. Gleba drying black, spores dark brown, ellipsoid or obovoid..... 12
11. Spores broadly ovoid or subspheroid, $8-9.6 \times 6.7-7.7\ \mu$..8. *M. Parksii* (p. 649)
11. Spores ovoid, ellipsoid to fusiform, somewhat truncate below, $8-9.6 \times 5.5-6\ \mu$7. *M. rubescens* (p. 648)
12. Spores less than $4\ \mu$ broad, $5.5-6.7 \times 2-3.7\ \mu$9. *M. mollis* (p. 650)
12. Spores $4\ \mu$ or more broad..... 13

13. Spores truncate, $6-8 \times 4-5 \mu$, exospore conspicuous. .10. *M. durissimus* (p. 650)
 13. Spores not truncate, $7.5-10.3 \times 5-7.5 \mu$, exospore not conspicuous.....
11. *M. variegatus* (p. 651)

1. *MELANOGASTER AMBIGUUS* (Vittadini) Tulasne, Ann. Sci. Nat. Bot. II. 19: 378. 1843.

Octaviania ambigua Vittadini, Monogr. Tuberac. 18. 1831.

Hyperrhiza liquaminosa Klotzsch in Dietrich, Fl. Reg. Boruss. [Fl. Königr. Preuss.] 7: no. 468. 1839.

Argyllum liquaminosum Wallroth, Fl. Cryptog. Germ. 2: 874. 1833.

Melanogaster Klotzschii Corda, Icones Fung. 5: 23. 1842; Anleit. z. Stud. Myc. 95. 1842.

Illustrations: Vittadini, Monogr. Tuberac. pl. 4, f. 7.

Type: location unknown to us but specimen so determined in Broome Herb. at British Museum. *Argyllum liquaminosum* from Thüringen, Wallroth.

Fructifications subspherical to ellipsoidal, 1-3.5 cm. in diameter, pale olive to olivaceous-brown when fresh, becoming cinnamon-brown to Prout's brown on drying, surface cottony-furfuraceous, fibrils scanty, inconspicuous; peridium 300-600 μ thick when fresh, somewhat thinner in old dry material, hyaline within, yellowish-brown toward surface, prosenchymatous, homogeneous, with outer filaments fraying out to form the more or less erect, brown tomentellum at the surface, of large, thick-walled, agglutinated hyphae which often collapse on drying; gleba black with yellowish septa, fundamental tramal tissue of more slender, smaller-celled prosenchyma, cavities filled with spores embedded in a gel; basidia clavate, evanescent, mostly 4-spored; spores (8-) 12-16 (-17) \times (5.5-) 6-8 (-8.5) μ , obovoid with more or less acute apex, approaching citriform, thick-walled, smooth, very often uniguttulate, dark brown when mature.

Under hardwoods. Central and western Europe, New York, Kentucky, Oregon, and New Zealand. April to October.

The specimen (Zeller Herb. 2338) collected by Dr. Helen M. Gilkey along Greecy Creek, Benton Co., Oregon, differs enough from *M. ambiguus* for us to refer it here with some doubt. The peridium in the one fructification has an outer white layer

(50–60 μ thick) which darkens when bruised as described for *M. aureus*. The inner peridium is dark brown (150–170 μ thick). The spores are as in *M. ambiguus*, but the cavities are filled with a meshy growth of hyphae bearing the basidia with no evidence of gelification.

GERMANY: Preussen, Neu Schöneberg bei Berlin, *F. Klotzsch*, type of *Hyporrhiza liquammosa* (Kew, Paris); Marburg, *E. Hesse*, 1885 (Farlow).

ENGLAND: Bristol, *C. E. Broome 355* (Brown Univ.); King's Lynn, *C. B. Plowright 503* (Brit. Mus., Stanford).

FRANCE: *L. Quélet* (Upsala); Seine, Bois de Boulogne, July 9, 1843, *L. Tulasne* (Paris).

ITALY: near Milano, *C. Vittadini* (Brit. Mus.).

NEW YORK: Syracuse, *L. H. Pennington* (Lloyd Mus. 87, and Dodge).

KENTUCKY: High Ridge, *C. O. Mattingly & F. T. McFarland* (Zeller).

OREGON: Benton County, Alsea Road, *H. P. Barsa* (Zeller 681), *H. M. Gilkey* (Dodge, and Zeller 2338, 2803, 2805); Corvallis, *L. M. Booser* (Dodge and Zeller 2285); Kings Valley, *S. M. Zeller 8187* (Zeller); Sulphur Springs, *H. M. Gilkey* (Zeller 6816).

NEW ZEALAND: Canterbury, Oxford, *G. Archer* (Cunningham 576, and Dodge); Wellington, *G. H. Cunningham*, 1928 (Dodge and Zeller); *Helen K. Dalrymple* (Lloyd Mus. 3, and Dodge).

1a. var. EURYSPERMUS Zeller & Dodge, Ann. Mo. Bot. Gard. 22: 373. 1935.

Type: in Zeller and Dodge Herbaria.

Fructifications globose to irregular, up to 3.5 cm. in diameter, snuff-brown to bister, not changing on drying, surface smooth, dull, fibrils few, concolorous, not extending halfway up, not distinctly radicate, adnate-appressed; peridium thick, tough, 320–400 μ thick, of dark-brown hyphae with thin walls, somewhat vesiculose, variable in size, closely stipose; gleba with white partitions (drying yellowish) and coal-black cavities, gelatinous, cavities up to 3 mm. thick, filled with spores at maturity; septa variable in thickness, hyaline, of small hyphae up to 2.5 μ in diameter; basidia with long slender (2.5 μ) pedicels of odd lengths, tips pyriform, $5 \times 7 \mu$, 4-spored, sterigmata short, up to 3 μ long; spores ellipsoid to citriform, black, $10\text{--}11 \times 7.5\text{--}9 \mu$ (usual mature spore $11 \times 8.5 \mu$); odor of Rhenish wine.

In strawberry patch. Oregon and California. March to April.

There were 37 fruiting bodies in the type collection. The odor is distinctive. The variety may be distinguished from the

typical species by the large cavities, white septa, the color of peridium, and more abundant spores.

OREGON: Polk County, Rickreall, *Etta Neiderheiser*, type (Zeller 2660, and Dodge); Benton County, Corvallis, *L. M. Booser* (Zeller 2346), *S. M. Zeller 7059* (Zeller).

CALIFORNIA: Santa Clara County, Call of the Wild, *H. E. Parks 137* (Univ. Cal. and Dodge).

2. *MELANOGASTER MACROSPORUS* Velenovsky, *České Houby*, 808. 1922.

Type: location unknown to us.

Fructifications tuberiform, fleshy, size of a walnut or even larger, brown when young, becoming dark horsechestnut-brown, soft, elastic, surface dull, thickly covered with long black fibrils; peridium very thin, black, not separable; gleba of black cavities with either yellowish or whitish septa, when ripe becoming gelatinous, blackish with yellowish veins; spores obovate-ellipsoid, narrower at the base, attached with 3-4 small bodies, reddish-brown, smooth, 15-18 μ long; odor very fetid.

In leaf humus of broad-leaved trees in summer, around Chuchle, common, in Trnova, Bechovice, and Karlstein. It seems to me that our fungus is *M. variegatus* Vitt. which is very often described in Germany and is quite common in other places. The spores appear ellipsoidal, 6 \times 10 μ ; either this size is wrong or our fungus is a new species. I have examined the spores very carefully from all points of view. —Velenovsky.

The following description is based on Oregon material which agrees closely enough with the above description to refer it here temporarily, pending opportunity to study the type:

Fructifications up to 12 \times 8 \times 6 cm. (weight 270 g. when fresh), drying russet to Mars brown and black; peridium duplex, outer layer about 140 μ thick, composed of loosely woven, periclinal, dark brown, thick-walled hyphae 7 μ in diameter, about 50 μ thick, of slender, gelified hyphae continuous with the septa; gleba black, mottled by white septa which are 90 μ thick, highly gelified; basidia evanescent; spores broadly obovoid, 12-15 \times 8-11 μ , dark brown; odor of spoiled silage or of onions without tear-producing qualities.

In duff under conifers, especially hemlock. Oregon. September.

OREGON: Clackamas County, on trail to Paradise Park from Twin Bridges Forest Camp, S. M. Zeller 7759, 8230 (Dodge and Zeller); Lane County, Belknap Springs, S. M. Zeller & G. E. Hoerner (Zeller 8241).

3. *MELANOASTER intermedius* (Berkeley) Zeller & Dodge, comb. nov.

Melanogaster ambiguus var. *intermedius* Berkeley, Ann. & Mag. Nat. Hist. I. 13: 352. 1844.

Type: in Broome Herb. at Brit. Mus. and Tulasne Herb. at Paris.

Fructifications 2-4.5 cm. in diameter, subglobose to reniform, fibrils plentiful below, at a definite place of attachment, surface even to undulating, tomentulose, very dark reddish-brown when fresh, becoming blackish where bruised, drying Prout's brown to mummy-brown; peridium 125-160 μ thick, light yellow to brownish near the exterior, stupose, of hyphae with vesiculose cells, homogeneous, but loosely woven at the surface with some erect hyphae giving the tomentulose character, distinct from the tramal tissue; gleba slaty-black, slightly lined or streaked with thin septa, of hyaline (dilute yellowish) gelified hyphae, cavities filled with spores in a gel; spores dark, mostly obovoid, obtuse, smooth, very rarely somewhat fusiform, tip subacute, 11-13 \times 7.4-8 μ ; odor strong, offensive, suggesting asafoetida.

Under hardwoods. England and central California.

ENGLAND: Wiltshire, Spy Park, C. E. Broome (Brit. Mus. and Paris).

CALIFORNIA: H. E. Parks, 551, 1123, 1124; Santa Clara County, Alma, H. E. Parks 7, 229, 2328, 405; Saratoga, Boys' Outing Farm, H. E. Parks 366; Brookdale, H. E. Parks 2162bis; Guadalupe Mines, H. E. Parks 23, 27, 225, 2349, 145, 381, 412, 416; highway to Watsonville, H. E. Parks 3307; Del Norte County, Crescent City, H. E. Parks 2862; Humboldt County, Trinidad, H. E. Parks 4122, 4436, 4443 (all Univ. Cal. and Dodge).

4. *MELANOASTER TUBERIFORMIS* Corda in Sturm, Deutschl. Fl. III. 11: 1. 1831.

Hyperrhiza tuberiformis Rabenhorst, Deutschl. Krypt. Fl. 1: 292-293. 1844.

Illustrations: Corda in Sturm, Deutschl. Fl. III. 11: pl. 1.

Type: Portions in Berkeley Herb. at Kew and Tulasne Herb. at Paris.

Fructifications 1.5-7 cm. in diameter when fresh, drying 1-

2 cm. (in material examined), subspherical, bay or reddish-fuscescous drying Rood's brown to Vandyke brown; fibrils rare, black, appressed, basal; peridium stipose, amber to darker, 100–185 μ thick; gleba black with white or slightly yellowish, inconspicuous septa, prosenchymatous, cavities very irregular; basidia evanescent, usually 8-spored; spores obovoid, sometimes pyriform, very dark brown, smooth, 10–11.5 \times 5.5–7 μ .

Under *Pinus*, *Erica*, *Quercus*. Central Europe and western North America. June to August.

CZECHOSLOVAKIA: near Praha, *Corda*, type (Kew and Paris); Böhmerwald, E. Soehner 774 (Soehner and Dodge).

GERMANY: Spiegelalust, R. Hesse (Farlow).

FRANCE: Alsace, Ballon, L. Quélet (Upsala).

IDAHO: Priest Lake, C. V. Piper (Lloyd Mus. 6164).

OREGON: Benton County, Corvallis, S. M. Zeller 7760 (Zeller).

CALIFORNIA: no locality nor collector (Univ. Cal. 552, and Dodge); Santa Clara County, Saratoga, H. E. Parks 968 (Univ. Cal. and Dodge); Marin County, Mill Valley, H. W. Harkness 5 (Stanford).

5. *MELANOGASTER MICROSPORUS* Velenovsky, České Houby, 809. 1922.

Type: location unknown to us.

In some respects similar to *M. rubescens* but it is larger, up to 8 cm. in diameter, without odor or with weak odor of meat. Spores very small, ellipsoidal, pointed on both ends, 4–5 μ , very thick-walled, light yellow.

In leaf mould in woods in Tuchomeric. July, 1918, J. Lissal. —Velenovsky.

Mattirolo, Beitr. Krypt.-Fl. Schweiz (Contr. Fl. Critt. Sviss.) 8²: 37–39. 1935, described a fungus as *M. microsporus* without reference to the previous use of the name by Velenovsky. His description follows:

Fructifications irregularly globose, size of a hazel nut, yellow-umber; peridium 150 μ thick, of three layers, the outer forming a tomentum, the middle deeply colored, of slender crowded hyphae, the inner layer hyaline, thicker, pseudoparenchymatous; gleba chestnut to fuliginous; basidia clavate, 4-spored; spores ellipsoidal, 3–4 \times 2 μ , similar to those of *Rhizopogon rubescens*.

Under chestnut and pine. Rodero. Como Province.

6. *MELANOGASTER BROOMEIANUS* Berkeley in Tulasne, Ann. Sci. Nat. Bot. II. 19: 377. 1843; Ann. & Mag. Nat. Hist. I. 13: 353. 1844.

Melanogaster variegatus var. *Broomeianus* Tulasne, Fung. Hypog. 93. 1851.

Tuber moschatum Sowerby, English Fung. pl. 426. 1815.—*non al.*

Illustrations: Tulasne, Ann. Sci. Nat. Bot. II. 19: pl. 18, f. 23.

Fructifications subglobose to irregularly lobed, often coalescing when cespitose, 2–4 cm. in diameter; surface ochraceous then Dresden brown with a flesh tint, becoming blackish where handled, drying tawny-olive to warm sepia, appressedly tomentulose; brownish fibrils below; peridium variable in thickness, 50–200 μ thick (mostly 50–100 μ), of stupose prosenchyma with large vesiculose cells, yellow-amber to darker toward the exterior, extending as fundamental tissue into the trama; gleba sooty-black, gelified, tramal septiments white to creamy, of subgelatinous hyaline hyphae, cavities filled with spores in a gel; spores light brown, narrowly oblong, broadly truncate below, (5–) 6–8.4 (–11) \times (2.5–) 3.5–4.0 (–4.5) μ ; odor of coffee grounds.

Under hardwood trees. July to February. Europe, Michigan, Indiana, and Oregon.

Close to *M. rubescens* in spore characters, but the spores are darker and definitely truncate below. Peanut-shaped spores are seldom found in this species, but even so they retain the truncate character.

EXSICCATI: Berkeley, British Fungi, 285.

U. S. S. R. [Kurland]: Lesten, *F. Bucholtz* (Farlow); Kuruka, Ternomorek, *F. Bucholtz* (Farlow); Moskva, Ocfalsbebe, *F. Bucholtz* (Farlow); Mikhailovskoe, *Bucholtz*, Aug. 4, 1899 (Farlow); Uerania, *Csernaiev* (Upsala).

SWEDEN: Upland, Upsala, Karolinaparken, *E. P. Fries*, 1853 (Upsala); *Th. M. Fries*, 1877, 1883 (Upsala); *Seth Lundell*, 1930 (Upsala and Dodge); *Harry Smith*, 1930 (Upsala and Dodge); Valby, Lidehall, *C. J. Cederström*, 18–10–91 (Upsala); Skåne, Ramlösa, *E. Melin* (Upsala).

AUSTRIA: Tirol, Füssen, *J. R. Weir* 22,291 (Dodge).

GERMANY: Würzburg, *E. Soehner* 1033 (Soehner and Dodge).

SWITZERLAND: Neuchatel, *P. Konrad* (Lloyd Mus. 050, and Dodge); Genève, Milan, *J. Müller* (Lloyd Mus. 05915, Dodge, and Stanford, ex herb. G. Winter).

ITALY: Como, Rodero, O. Mattiolo, Aug. and Oct. 1900 (Lloyd Mus. 081, 08709, Dodge); near Milano, no collector (Stanford, ex herb. G. Winter); Trentino, G. Bresadola (Upsala).

FRANCE: Alsace, L. Quélet (Paris); Eure, Andelys, G. Malençon (Dodge); Loiret, Port pres Gien, L. Tulasne, Oct. 1843 (Paris); Seine-et-Marne, Vincennes, L. Tulasne (Paris); Versailles, L. Tulasne (Paris).

ENGLAND: Wiltshire, Rudloe, C. E. Broome, Oct. 11, 1842 (Brit. Mus., and Brown Univ.); without locality, Berkeley, British Fungi, 285.

MICHIGAN: Ann Arbor, L. E. Ekvall 19 (Univ. Mich.); Saginaw Forest, C. H. Kauffman 22 (Univ. Mich.); School Girls Glen, A. H. Smith (Univ. Mich.).

INDIANA: Lafayette, Happy Hollow, H. S. Jackson (Dodge, and Zeller 2806).

OREGON: Benton County, Corvallis, S. M. Zeller 1787, 1898, 2242 (Zeller); Wren, L. M. Booser (Zeller 855); Lincoln County, Waldport, S. M. Zeller 4996 (Zeller).

7. *MELANOGASTER RUBESCENS* (Vittadini) Tulasne, Fung. Hypog. 96. 1851.

Octaviania rubescens Vittadini, Monogr. Tuberac. 18. 1831.

Hyperrhiza rubescens Rabenhorst, Deutschl. Krypt.-Fl. 1: 293. 1844.

Bondatia oleodora Lespiauult, herb. nom.

Melanogaster nauseosus Coker & Couch, Gast. Eastern U. S. & Canada, 39. 1928.

Type: in Broome Herb. at Brit. Mus., Berkeley Herb. at Kew, and Tulasne Herb. at Paris. The type of *M. nauseosus* from Univ. North Carolina Herb.

Fructifications subglobose to elongate, irregularly sulcate, 1.5–3 cm. in diameter; surface tomentulose, even to reticulately ridged, light brownish when fresh, drying raw umber or darker; fibrils absent; peridium spongy, stupose, homogeneous, darker brown toward outer surface, drying 100–200 μ thick, distinct from tramal tissues; gleba moist, bluish-white when fresh, reddening and yellowing when freshly cut, drying brownish-black; septa broad, variable, cinnamon-buff; cavities rounded, not crowded, at first filled with dark claret-brown or darker spore masses, later becoming hollow, due to the relatively few spores scattered through the cavity gel; basidia clavate, unevenly distributed on the branching hyphae of the cavities; spores oblong-fusiform to ovoid-ellipsoid, or curved, somewhat irregular (often the shape of the fruit of *Arachis hypogaea*), 8–9.6 (–11.8) \times 5.5–6.5 μ , light yellow, pellucid.

Southwestern Europe and eastern North America. July to November.

The specimen from Italy collected by Mattiolo differs from the other material of this species in having long narrow spores which measure $11-13 \times 3.5-4 \mu$. It is with some hesitation that we have referred this specimen to *M. rubescens* (Vitt.) Tul.

The specimen from Ithaca, in alcohol, shows a peridium $650-750 \mu$ thick, drying as thin as the peridium in the type.

ITALY: Como, Rodero, O. Mattiolo, Oct. 1905 (Dodge); Lombardia, near Milano, C. Vittadini, type (Paris, Kew, and Brit. Mus.).

FRANCE: Lot-et-Garonne, Nerac, Lespiault (*Bondatia oleodora* herb nom., Paris).

NEW YORK: Ithaca, Beebe Lake, H. H. Whetzel (Atkinson Herb. at Cornell 13679, Dodge, and Zeller 1446).

PENNSYLVANIA: Mt. Pocono, Schweinitz 2210 (sub *Ehisopogon aestivus* in Curtis Herb. at Farlow).

NORTH CAROLINA: Orange County, Chapel Hill, J. N. & E. E. Couch (type of *M. nauseosus*, Univ. N. C. 8281); Watauga County, Blowing Rock, Coker et al. (Univ. N. C. 5804).

ALABAMA: Sepaly, Payne's Mills, P. P. Payne (Lloyd Mus. 041).

8. MELANOASTER *Parksii* Zeller & Dodge, sp. nov.

Type: Univ. Cal., Dodge, and Zeller Herbaria.

Fructificationes irregulares vel subsphaericae, 2-4 cm. diametro, fibrillae basi prominentes, brunneae nigrescentes, siccatae "Dresden brown" vel "Mars brown," obscuriores contusae, superficie aequo vel undulato, tomentuloso vel glabro; peridium prosenchymaticum, cellulis magnis spongiosis contextum, dilute luteum, externe obscurius, $300-480 \mu$ crassitudine; gleba "Brussels brown" vel "warm buff" siccata, locellis in centro fructificationis subcavis; basidia non visa; sporaе late obovoideae vel subsphaeroideae, dilute brunneae, sub lente pellucidae, $8-9.6 \times 6.7-7.7 \mu$.

Fructifications irregular to subspherical, 2-4 cm. in diameter, dark brown to black, drying Dresden brown to Mars brown, darker where bruised, surface even or undulating, tomentulose to glabrous, basal fibrils prominent; peridium spongy, prosenchymatous, of large cells, light yellow, darker toward the peridium, $300-480 \mu$ thick; gleba Brussels brown [dry], central cavities more or less hollow when dry with whitish or warm buff, gelified septa; basidia not seen; spores broadly obovoid to subspheroid, light brown, pellucid, $8-9.6 \times 6.7-7.7 \mu$; odor pungent, spreading.

Deeply buried under leaves of *Quercus agrifolia*. California. April.

CALIFORNIA: Santa Clara County, Call of the Wild, *H. E. Parks 136a* (Univ. Cal., Dodge, and Zeller 1412); Guadalupe Mines, *H. E. Parks 136*, type (Univ. Cal., Dodge, and Zeller 1655).

9. *MELANOASTER MOLLIS* Lloyd, Myc. Notes 65: 1047. 1921 (see also p. 1065).

Illustrations: Lloyd, Myc. Notes 65: *f. 1939*.

Type: In Lloyd Mus., Dodge, and Zeller Herbaria.

Fructifications subglobose, collapsing at maturity, 2.5–3 cm. in diameter, drying Dresden brown to mummy-brown, pruinose to smooth where rubbed, distinct fibrils below; peridium thin, 80–130 μ thick, simplex, stupose, hyaline with brownish exterior; gleba in general black, drying hollow, tramal tissues whitish, then gelatinizing, prosenchymatous, basidia-bearing cavities filled with the deliquescent hyphae, basidia, and spores; spores small, dark brown, ellipsoid, smooth, 5.5–6.7 \times 2–3.7 μ ; odor disagreeable, rancid.

In black vegetable humus, hypogeous or emersed, among greasewood.

Melanogaster mollis Lloyd (except for *M. microsporus*) has the smallest spores of any known species. In the type collection the fructifications are extremely mature, with the gleba becoming deliquescent, drying with large hollows.

WYOMING: [Fremont County, Meeteetse, 6700 feet alt.], *Simon Davis*,¹ type (Lloyd Mus. 041, Dodge, and Zeller).

PORTUGAL: *J. Rick* (Lloyd Mus. 05348, and Dodge).

10. *MELANOASTER DURISSIMUS* Cooke, Grevillea 7: 94. 1879.

Type: India, Chakrata, 8000' north of Delhi, *Baden Powell*.

Fructifications compressed, sulcate, subspherical to reniform, smooth, up to 4 cm. in diameter, drying 2 \times 1 \times 1 cm., very hard, dark fuscous to sepia, cottony-furfuraceous, rubbing glabrous, no fibrils; peridium stupose, 90–115 μ thick, amber; gleba black with buff-white septa of close gelified pros-

¹ Lloyd did not record the data on this specimen, and the late Mrs. E. B. Blackford assured Dodge that she has been unable to locate a duplicate in Simon Davis' collections but she found notes for *Calvatia defodioides* Lloyd from this locality, and it is probable that all of his collections from Wyoming came from the same locality.

enchyma; basidia evanescent; spores $6-8 \times 4-5 \mu$, ellipsoid, very truncate at base, smooth, dark brown, exospore not conspicuous.

British India. November to February.

Baden Powell, the collector of the type, notes that this species is cooked and eaten by the natives, who report that chewing a little piece keeps off thirst in crossing high passes. The natives report it common in the hills of Kangra and in the Upper Chenab valley.

BRITISH INDIA: Chakrata, B. Powell, type (!); Simla, J. M. Clark, 7 Feb. 1879 (Brit. Mus. and Kew); J. H. Burhill, Nov. 8, 1902 (Lloyd Mus. 7331, com. E. J. Butler 14945).

11. MELANOASTER VARIEGATUS (Vittadini) Tulasne, Ann. Sci. Nat. Bot. II. 19: 377. 1843.

Octaviania variegata Vittadini, Monogr. Tuberac. 16. 1831.

?*Tuber moschatum* Bull. Champ. 1: 79. 1789.

Hyperrhiza variegata Rabenhorst, Deutschl. Krypt.-Fl. 1: 293. 1844.—non al.

Illustrations: Vittadini, Monogr. Tuberac. pl. 3, f. 4; Bull. Champ. 1: pl. 479.

Type: della Pistola and along R. Lambro near Milano, Lombardia, Vittadini. Specimens sent by Vittadini in Sprague Collection at Harvard Univ., in Berkeley Herb. at Kew, and in Paris (com. Ardissonne).

Fructifications rounded, irregular, the size of a hen's egg or fist, drying 2 cm. in greatest diameter, smooth, ochraceo-ferugineous drying Verona brown, fibrils basal, fuscous; peridium stupose, $100-160 \mu$ thick, amber-yellowish, extending as fundamental tissue into the trama; gleba yellowish-ashy at first, becoming black, with thin yellow-orange septa, cavities subpentagonal; basidia evanescent; spores ellipsoidal, very dark brown, $7.5-10 \times 5-7.5 \mu$, smooth.

Under *Quercus* and *Cistus monspeliensis*. Northern Italy, Algeria, and California. August to December.

It is with some hesitation that we have referred Parks Z22 to this species, owing to its texture resembling *Hymenogaster*, and to the absence of gel filling the cavities.

ITALY: Lombardia, *C. Vittadini*, type (Paris, com. Ardissonne, Kew, and Farlow); agro panormilano, *Insenga* (det. *Tuber Borchii*, Paris).

ALGERIA: Alger, *Durieu de Maisonneuve* (Paris).

CALIFORNIA: Santa Clara County, Guadalupe Mines, *H. E. Parks 958* (Univ. Cal. and Dodge); Saratoga, *H. E. Parks 222* (Univ. Cal., Dodge, and Zeller); Marin County, San Rafael, *H. E. Parks 2059* (Univ. Cal.).

DOUBTFUL SPECIES

MELANOASTER SARCOMELAS (Vittadini) Tulasne, Fung. Hypog. 97. 1851.

Octaviana sarcomelas Vittadini, Monogr. Tuberac. 16. 1831.

Hyperrhiza sarcomelas Rabenhorst, Deutschl. Krypt.-Fl. 1: 293. 1844.

Type: Lombardia, *Vittadini*, not seen.

Fructifications small, irregular; peridium smooth, without rooting appendages; gleba very black, uniform in color; cells regular, contents gelified, filled with spores; spores ovoid, smooth, somewhat larger. Strong odor of ink. Fungus the size and form of a seed of *Faba*, with a thin peridium; base hardly distinguishable. Cavities rhomboidal or pentagonal, septa ashy, pellucid, opaque in center. When dry contracting into a solid perennial mass.—Vittadini.

A careful study of the original descriptions of Vittadini's species suggests that *M. sarcomelas* may be a synonym of *M. tuberiformis* Corda. In spite of searches by Tulasne, Mattiolo, and Lloyd, the type of this species has not been found.

MELANOASTER ODORATISSIMUS (Vitt.) Tulasne, Fung. Hypog. 95-96. 1851.

Octaviana odoratissima Vittadini, Monogr. Tuberac. 19. 1831.

Hyperrhiza odoratissima Rabenhorst, Deutschl. Krypt.-Fl. 1: 293. 1844.

Type: two fructifications from oak woods across the Po near Milano, *Vittadini*, April, probably lost.

Fructifications subspherical, sub-smooth, golden-rufous, with basal appendage. Gleba tough, pulpy, rufous-brown with septa; cavities not conspicuous, never empty; spores ovoid, umber. Odor of *Hya-cinthus botryoides*. Fructifications the size of a chestnut; peridium with rooting fibrils as in *M. variegatus*, golden at first, then rufous;

gleba suggesting the pulp of red beets; cavities not very distinct; spores rare.—Vittadini.

Hesse, 'Die Hypogaeen Deutschlands' 1: 64-65, *pl. 4, f. 10-14, pl. 8, f. 8*. 1891, has referred here material collected at Michelbach near Marburg, in 1884, but we have been unable to see this material. He describes it as follows:

Fructifications spherical, from size of a large hazel-nut to that of a sparrow egg, golden-yellow becoming deep red-brown, smooth, odor of *Hyacinthus botryoides*; peridium not easily separable from the gleba, composed of gelified hyphae, becoming deep reddish-brown; septa at first golden, becoming reddish; clamp connections prominent in the mycelium of the cavities bearing the basidia, which are mostly 8-spored; spores almost ovoid [figures show them ellipsoid to almost allantoid], brown, size not given, but if magnification of figures is correct spores about $7-8 \times 4-5 \mu$.

There seems little to distinguish Hesse's concept of *M. odoratissimus* from *M. Broomeianus* Berk.

BULLARDIA INQUINANS Junghuhn, *Linnaea* 5: 408. 1830.

Argyrium inquinans Wallroth, *Fl. Cryptog. Germ.* 2: 873. 1833.

Hyperrhiza inquinans Rabenhorst, *Deutschl. Krypt.-Fl.* 1: 292. 1844.

Illustrations: Junghuhn, *Linnaea* 5: *pl. 6, f. 15*.

Type: Germany: between Rammelburg and Klaus, *F. Junghuhn*, not seen.

Fructifications up to the size of a walnut, irregular, gibbous, smooth; peridium thin, sometimes ruptured at maturity; fibrils sparse, appressed; gleba black; septa white, composed of branched, loosely woven hyphae; basidia scattered throughout the cavities; spores black. Odor sweet, pleasant, almost aromatic; taste very sweet.—Junghuhn.

Under *Corylus Avellana* L. Germany. September.

While there seems no doubt that the above description refers to a species of *Melanogaster*, it is too brief and generalized to refer definitely to a species. It is probably not *M. variegatus*, to which it has been generally referred, as that Mediterranean

species is not known north of the Alps. It is much more probably *M. tuberiformis* or *M. Broomeianus*.

MELANOASTER TUBEROSUM (Fr.)

Polysaccum tuberosum Fries, Syst. Myc. 3: 55. 1829; *Linnaea* 5: 695. 1830.

Lycoperdoides tuberosum, ferrugineum, arrhizon, pulpa nigra, Micheli, Nova Pl. Gen. 219. 1729.

Hyperhiza tuberosa Fries, Ind. Syst. Myc. 102. 1832; *Summa Veg. Scand.* 437. 1849.

cf. Th. M. Fries, *Svensk Bot. Tidskr.* 3: 293. 1909.

Illustrations: Micheli, *Nova Gen. Pl.* pl. 98, f. 2.

Type: "In pratis calcareis," Malmoe, Sweden, along with *Bovista suberosa*. Angelin:

Fructifications without roots, round, irregular, often oblong, suggesting a small tuber of *Solanum*, the size of a walnut (*Juglans*), soft when young, becoming hard; peridium coriaceous, ferrugineous, smooth, almost pruinose under a lens, not dehiscent; gleba with white or yellow septa, cavities very black, large, round or irregular, producing a black viscid ink with a very foul odor, filled with spores when mature; no capillitium.—Fries.

Since *M. Broomeanus* Berk. is the only species of this genus so far found in Sweden, of which we have seen specimens, it is likely that *M. tuberosum* may be the same fungus. However, we prefer not to reduce *M. Broomeanus* to synonymy until we have had an opportunity to study the type, if it still survives.

MELANOASTER AUREUS (Vittadini) Tulasne, *Fung. Hypog.* 97. 1851.

Octaviania aurea Vittadini, *Monogr. Tuberac.* 20. 1831.

Hyperhiza aurea Rabenhorst, *Deutschl. Krypt.-Fl.* 1: 293. 1844.

Illustrations: Vittadini, *Monogr. Tuberac.* pl. 3, f. 14.

Type: in forest on hill near La Stradella, near Milano, summer, C. Vittadini, apparently lost.

Fructification oblong, reniform, rooting at the base, peridium smooth, at first whitish. Gleba hard at first, golden, with white veins (septa) variegated, then soft, blackening, somewhat hollow.

Odor pleasant. Fungus size of a filbert, peridium thin, becoming fuscous at the touch, with a radiciform appendage. Cavities not numerous, rounded or elongate, suggesting the pores of *Boletus*, golden-shining within. Septa thick, whitish-citrine. Cut gleba becoming greenish, but at maturity breaking down into a blackish sporiferous pulp.—Vittadini.

EXCLUDED SPECIES

Melanogaster Wilsonii Lloyd, Myc. Notes 68: 1176, 1923, is RHIZOPOGON *Wilsonii*. Zeller & Dodge, comb. nov.

Melanogaster carolinensis (Bosc) DeToni in Sacc. Syll. Fung. 7: 167. 1888.

Uperhiza Bosc, Ges. Naturf. Freunde Berlin Mag. 5: 88, pl. 6, f. 62. 1811.

Uperhiza carolinensis Nees ab Esenbeck, Syst. d. Pilze 1: 159, pl. 15, f. 146. 1816.

Hyperrhiza caroliniensis Sprengel, Syst. Veg. 4: 416. 1827.

Uperhiza Boscii Schweinitz, Syn. Am. Bor. 255. 1834; Lloyd, Myc. Notes 30: 395. 1908. Curtis states that the Schweinitz specimen is a bad *Scleroderma*? from Mt. Pocono, Pa.

Type: Carolina, Bosc; probably lost.

A careful study of the original description and figures suggests *Scleroderma* sp. but in the absence of the type its identity remains doubtful.

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